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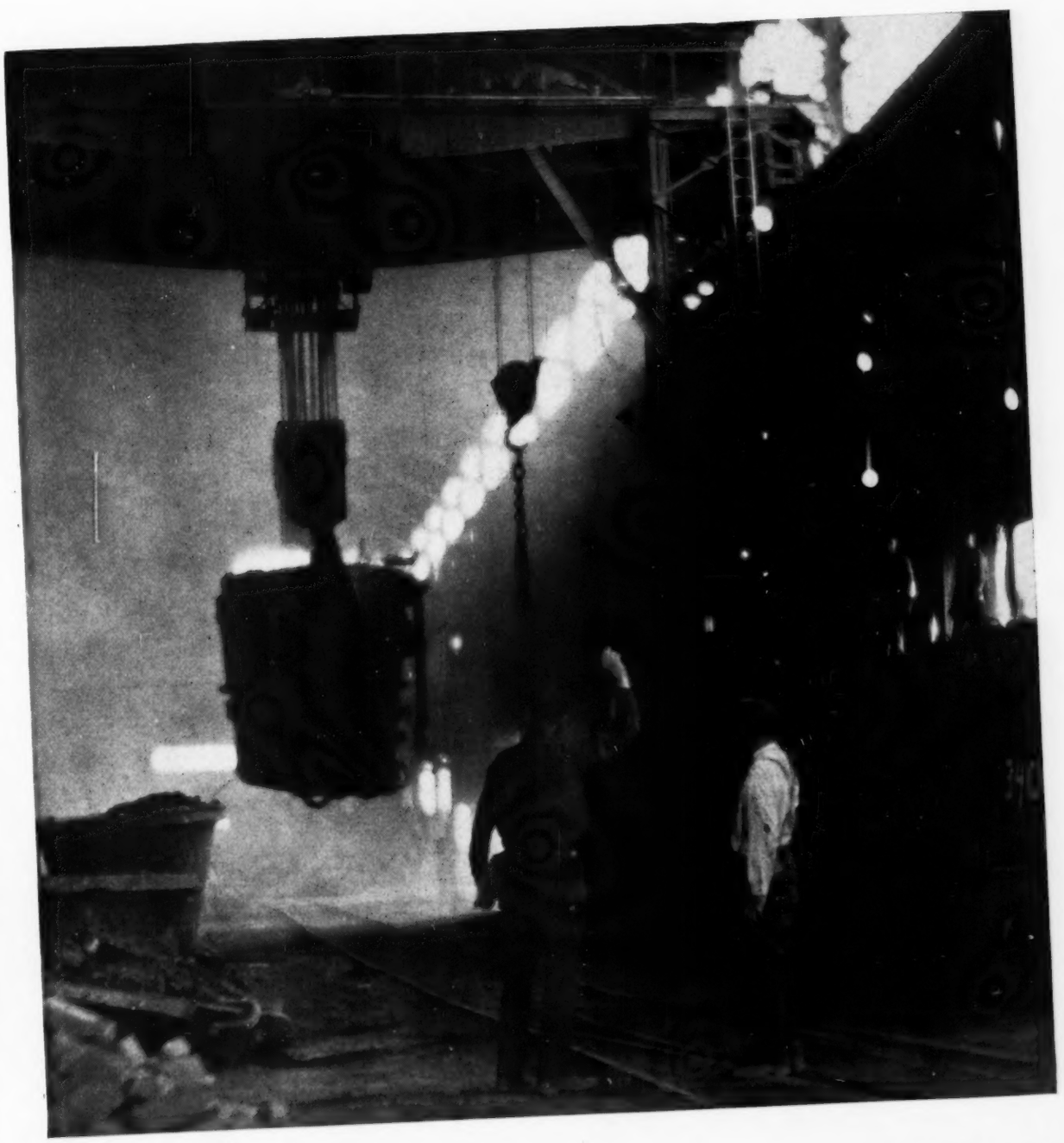
Engineering and Mining Journal

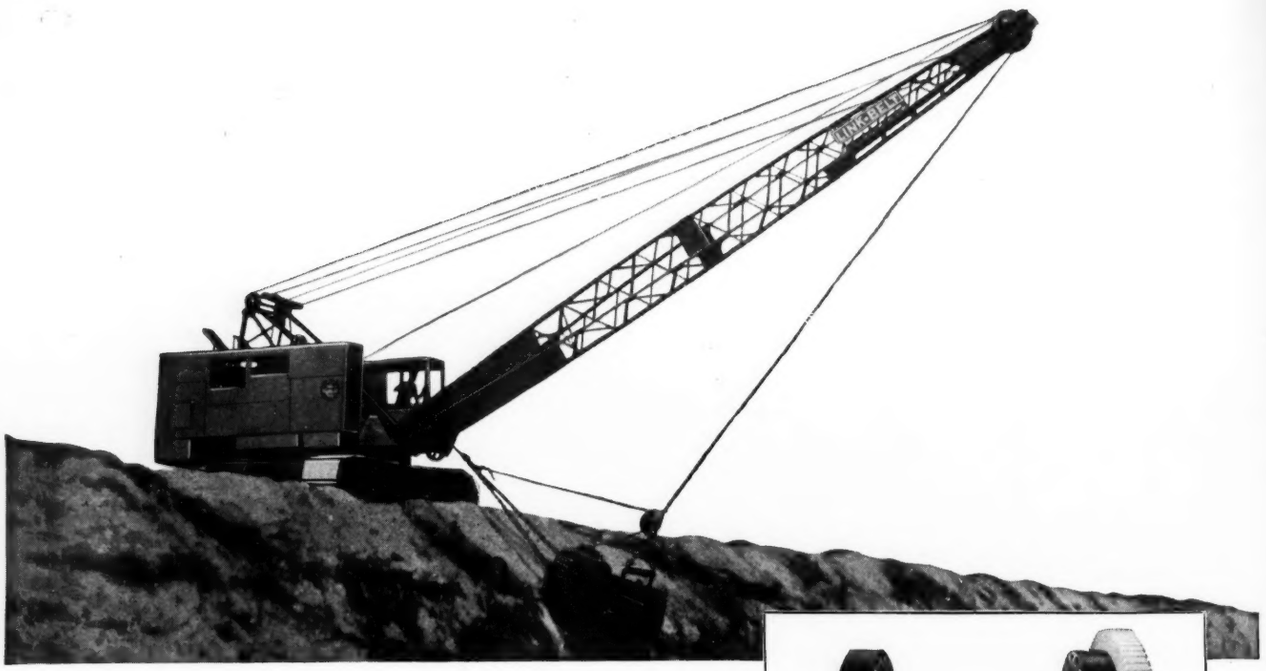
McGraw-Hill Publishing Company, Inc.

Price 25c. per copy



Molten metal in transit

October 26, 1931



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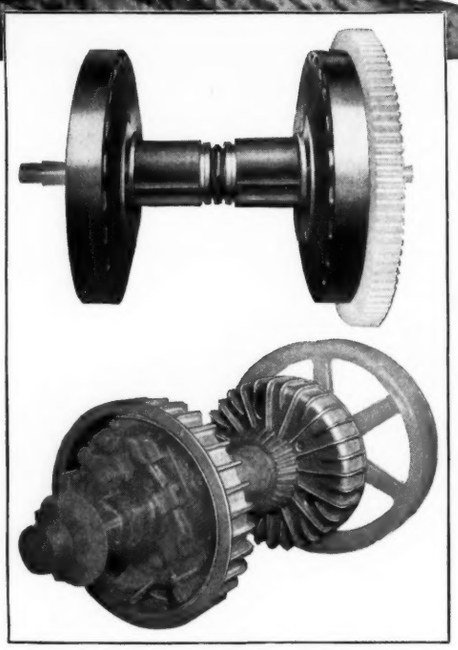

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Engineering and Mining Journal

October 26, 1931 A. W. ALLEN, *Editor* Vol. 132—No. 8

Sickness Brings Plans for Health

PROPOSALS for ending the depression are legion. Every published thought and private aspiration seems to have been garnered and classified in order to construct a plan to attract public attention and to stimulate interest. The somewhat radical utterances of yesteryear form the basis of programs of reform that are considered temperate and moderate today. As the discussions on these plans wax and wane, with no board of umpires to separate the chaff from the wheat, time passes with inexorable swiftness away from the period when real reforms should have been initiated.

This publication is still inclined to the belief that it was right in 1928, at the peak of the boom period, in supporting the proposal for a three thousand million dollar State and Federal reserve construction fund, "for use in times of industrial depression"—a possibility that too many individuals in responsible and influential positions refused to consider as within the realm of practical politics. The money could readily have been provided then, and the machinery put in motion at the first signs of national distress. Had this been done, the intensity of the depression would have been softened and work would have displaced charity as an emergency provision.

The ease with which government issues for large amounts have been absorbed in recent weeks indicates that such financing for constructive work, as a corrective of unemployment, may be more practicable than and preferable to charity by local doles. The United States possesses adequate collateral in natural, institutional, and corporate resources, over all of which the government is the guardian for the good of the people. Federal authorities are surely obligated to utilize this collateral in time of domestic emergency, and to guarantee the principal on loans made with such backing. Only nominal interest rates would be expected. To many observers a duty seems clear to those who have sought and accepted positions of high responsibility and trust in national affairs, a duty that cannot be camouflaged by deploring expected effects of collectivism in Russia or unemployment insurance in Great Britain.

As with a reserve construction fund, so with other plans that seek to ameliorate the results of a condition of economic disequilibrium. To take out health insurance when one is sick or accident insurance when one is disabled is expensive if not impracticable. The American people have completed a second year of economic *malaise,* an ailment that is still being treated by prominent publicists with the comforting opiate that such indisposition is a fairly regular occurrence, from which, if history repeats itself, as it is expected to do, recovery is certain. And as soon as the patient becomes convalescent, an atmosphere of national self-satisfaction will, if history again repeats itself, cause him to live for the day only, with thought of the future solely in respect to mortgage and installment obligations.

Those in responsible positions who are unwilling to admit that profound change is taking place, and that the sequence of depression and recovery does not invariably obey any law promulgated in the halls of Congress, will be interested to learn that, in one American city at least, racketeering is coming to the aid of business in its effort to outlaw cutthroat price concessions that are engendered neither by difference in quality nor service—a condition typical of the status in the metal industries. Machine guns are likely to be brought into action against a loyal supporter of a national policy of industrial conflict and bitter competition that is forcing business as a whole, and not merely its weaker elements only, to the wall; excluding, of course, any group that happens to be in the fortunate position of the telephone industry, which regulates itself so satisfactorily under federal supervision in the public interest that it can, in this time of stress, spare its highest executive to direct unemployment relief throughout the country as a whole.

Readers will recall that this publication during 1927-29 urged greater cooperation among the various units of an industry, and a modification of the anti-trust laws to permit agreement on production control and price stabilization, under helpful governmental direction and regulation. These recommendations constitute essential features of the Swope plan recently proposed, and they deserve as serious consideration in these times of depression as this publication believed they deserved during the preceding period of high prices and negligible unemployment.

Heat Conservation by Mineral Insulation

THE insulation of dwelling houses, to conserve heat in winter and to exclude it in summer, remains a field that is almost wholly neglected. Vast numbers of roofs are reshingled yearly, but only in rare instances is a thought given to means whereby the usual loss of heat in winter is prevented by insulation. In houses that consume large quantities of fuel per season—houses that are maintained at a comfortable temperature throughout the winter—the attic rooms are usually raw and uninhabitable, because of the loss of heat through the roof, despite the fact that it can be made of non-conductive materials, or lined easily

and cheaply with an appropriate type of mineral insulator.

Attention was recently directed to the use of electricity to warm dwellings, by means of water raised in temperature during off-peak periods, when the cost of current is low, and stored in insulated accumulators. A photographic reproduction of a model house appeared as illustration to a magazine article on the subject, from the roof of which house all the snow had evidently been melted, although the lawns and sidewalks were covered with a mantle of white.

The warming of a house roof with hot air, and the destruction of that natural insulator, snow, is characteristic of most modern dwellings. A significant exception was noted this spring in a Western university town, where one roof remained conspicuous throughout a severe winter because its blanket of snow remained intact. The designer and owner had taken advantage of the fact that a special gypsum preparation could be easily and cheaply laid beneath the shingles, with the result that fuel costs were considerably reduced, and the attic was maintained throughout the winter at a warm and comfortable temperature. A publication of facts indicating low costs of such insulation and the saving of fuel resulting, to say nothing of the additional comfort secured, would greatly stimulate interest in house insulation by non-metallic mineral products.

A New Phase of Gold Mining

WHAT became of all the graduates of mining schools this year? Doubtless this question has occurred to many older engineers who know only too well that at the curtailed rate of present operations the mining industry has not even enough work for its experienced personnel. But gold mining, of course, has been flourishing, and a much greater proportion of mining recruits than usual is apparently getting its first practical experience in washing gravel, following a thin vein, cleaning amalgamated plates, or testing cyanide solution. However, even the prosperous and expanding gold-mining companies cannot absorb all of the overflow from the base-metal mining industry, so an effort has been made to start active development of promising gold prospects, and to secure favorable leases on old mines.

In a recent issue a news item told of a project for the students of the Alaska School of Mines to work the Eva gold mine, near Ferry, on the Alaska Railroad, equipment for which has been ordered by the college. This will be a school of practical experience for both undergraduates and graduates, presumably, and may result in some added income for the college as well. Another project is being sponsored by the Alumni Association of the Colorado School of Mines. A company known as Engineers Lease, Incorporated, has been formed, and has taken leases on certain blocks in the old Vindicator mine, at Cripple Creek. This mine was considered a good many years ago to have had its day, but many undeveloped mineralized fissures and some low-grade ore still offer possibilities for the individual operator who pays his own wages. The work in the Vindicator is expected to provide employment for 100 graduates, who will work on a grubstake basis, receiving $1.25 a day to cover expenses of board and lodging. The company formed by the Alumni Association will furnish mining equipment and supplies, and will receive two-fifths of the proceeds; the Association itself will get one-fifth; and the other two-fifths will go to the men who do the work.

Possibilities exist for similar assistance to many other unemployed mining engineers. Alumni associations, mining companies, and other groups could well formulate similar plans for the development of promising gold areas at small expense for wages, with possibility of ultimate profit, affording subsistence at least to deserving men.

Necessity and Ingenuity in Filtration Practice

FILTRATION has been defined as the complex process of separating, so far as possible, by vacuum or pressure, liquid from solid; removing the residual solution by washing; and, at the same time, leaching any recrystallized, absorbed, or undissolved matter by percolation. Since the invention of successful types of vacuum filters in the early application of the cyanide process, tremendous advances in technique have taken place. Vacuum filtration is successfully used in a dozen or more industries, constituting a tribute to the skill and inventive genius of Moore, Butters, Oliver, and many other engineers less well known than are these pioneers.

A major advantage in the separation of solid from liquid by vacuum is that the low (atmospheric) pressure used results in the formation of a loose deposit. This is of no advantage, however, if the machine is used solely as a dewaterer. But one of the most important phases of filtration, as defined in the foregoing, is the step of displacing with water a valuable or contaminating solution. This displacement would be effected under ideal conditions if the loose structure of the cake were left undisturbed between formation and washing; but an aggregation of the particles of which it is composed is inevitable when the cake emerges from the pulp, a vacuum being necessary with most types of filters to hold it in position, although such vacuum is usually reduced to prevent a too-sudden or too-complete drying, and consequent cracking, which would militate against satisfactory washing.

Several years ago the designer of an intermittent, basket-type vacuum-filter plant neglected necessary precautions in the provision and arrangement of auxiliary apparatus, with the result that the interval between exposure of the cake, by the withdrawal of excess pulp, and submergence of the cake in the displacing solution was so protracted that successful washing was impossible. Without a comparatively high vacuum the cakes dropped into the hopper. With an adequate vacuum to hold them in place, pitting and cracking would occur.

The metallurgist who took charge of the plant immediately after its erection, realizing the impossibility of satisfactory result by any known modification of normal operation, evolved the somewhat bold expedient of avoiding exposure of the cake by simultaneously following the pulp, as withdrawn, with wash solution. The aggrega-

tion of the particles of slime in the exposed cake was thereby prevented, washing followed cake formation without interruption, and contamination of wash with pulp was found to be confined to a comparatively narrow horizontal zone. Displacement by washing proved to be highly efficient. The cake retained its loose structure to such an extent that the rate of flow of wash solution had to be curtailed, lest pitting occur, by a radical reduction in vacuum—to far below the normal amount needed for washing after customary exposure and aggregation of the solids in the cake.

Vacuum filtration is being applied to a widening variety of purposes, in connection with the treatment of raw and processed material, crystalline and amorphous, coarse and fine. To engineers who are faced with an unusual problem, an investigation of the advantages of simultaneously replacing pulp with wash solution may suggest an opportunity to increase unit capacity and to secure a higher displacement efficiency.

Questionable Methods of Financing Mines

RECENTLY an advertisement appeared in the *San Francisco Chronicle* in which a group of brokers offered to sell common capital stock of the Bellevue Mining Company for $5 per share. A description of the property, its history, and the names of examining engineers and company officials was followed by the statement that proceeds from the present financing are to be utilized in completing the acquisition, development, and operation of the Bellevue mine—a drift property that has been idle for several years. No mention was made of the price to be paid for the property or of the present status of ownership.

The Bellevue Mining Company was given a permit by the California Corporation Department to sell not more than 200,000 of its 350,000 shares for $2.75 per share. Subsequently, apparently, the company was authorized to sell 50,000 shares at $2.75 per share to a firm of San Francisco brokers, payments to be made at intervals in stipulated amounts. This financing company discloses, apparently, a purpose to sell its stock at $5 per share, or an advance of $2.25 per share. The status of this block of 50,000 shares is as follows: If sold, the total amount paid by the stockholders would be $250,000, of which the mining company would receive $137,500 and the financing company $112,500. Each dollar of the shareholders' money would be represented by only 55 cents in the treasury of the company.

In the case of another drift property, the Calaveras Central, 200,000 shares are said to have been sold to brokers, under the terms of the Corporation Commission's permit, the first 25,000 shares at 25 cents per share, and successive blocks of 25,000 shares at an increase of 5 cents per share, making the average price to the brokers 42.5 cents per share. The total payment to the mining company was $85,000. The shares were sold on exchanges at the probable average price of $1.25 per share, or a total of $250,000. In this case one dollar of the stockholders' money was represented by 34 cents. Similar methods were followed in the financing of several other California gold properties. In each instance the "financing" company certainly retained a liberal proportion of the stockholders' investment, and the mining companies forfeited reputation and standing.

The California State Corporation Department is entrusted with the duty of protecting security buyers from unreasonable exploitation, yet the permits of that Department apparently offer little or no limit to the price charged the ultimate buyer. Unless fairer methods of financing are practiced, legitimate mining will find difficulty in obtaining capital for the exploitation and development of meritorious prospects.

Opportunities for Metals in the Building Field

CONFIDENCE in the future of industry is displayed in a special message to steel constructors, issued by the American Institute of Steel Construction. Concrete evidence of this confidence is also presented in the increased contributions for the present year for cooperative work conducted by the Institute. United States Steel Corporation and Bethlehem Steel both raised their contributions for the year from $25,000 to $50,000, and other firms have followed their example. The message points to the important fact that the volume of building planned, public and private, exceeds six thousand million dollars, and that contracts involving two thousand million dollars have been placed since December, 1930.

Developments of recent years have repeatedly brought out the fact that many a need may exist before the public at large has recognized it as such or has shown inclination or willingness to satisfy it. Much responsibility, therefore, rests with industrial leaders, in anticipating needs and studying wholesome trends. The principal objective of any legitimate business, after all, is service. Cynics, sneering at such an idea, may state that evidence of such principles in modern business is prompted by hypocrisy rather than by a genuine desire for higher standards. Granting that this may be true in some cases, may one not find satisfaction in the fact that a correct attitude receives recognition at all. "Hypocrisy," a philosopher states, "is the homage vice pays to virtue."

The need for improvement in the building field, so clearly recognized by the steel constructors, presents equal opportunities for producers of non-ferrous metals. A vigorous policy to supply this need offers attractive compensation, in addition to the satisfaction that is always the reward of constructive service. Much has already been gained in this direction, as a survey of the modern business structure would reveal. The fact must, however, be brought home that this increasing use of non-ferrous metals is not only a tribute to their esthetic qualities, but that the many advantages in construction and upkeep are sufficient to make their selection desirable for economic reasons as well; that the big concern erecting a towering skyscraper is probably analyzing expenditures even more carefully than is the individual who is putting his savings in a home. The home owner will not hesitate to grasp the opportunity presented if he is convinced that tangible economies are possible.

The Boleo Enterprise

John B. Huttl
Assistant Editor

The Boleo smelter

For more than 45 years the Compagnie Du Boleo has been a leading copper producer of Mexico. The achievement of this noteworthy record has, however, not been without difficulty. Adverse climatic conditions, isolation from inland centers, and technical problems of a particularly complex character are but a few of the obstacles with which the management has had to contend. The general description of the property presented here will be followed by other articles, from members of the staff, that will consider in more detail the various phases of Boleo operations.

Port Santa Rosalia

THE mines and smelter of the Compagnie Du Boleo, a French corporation capitalized at 72,000,000 francs, are situated at Santa Rosalia, about 260 miles north of La Paz, the capital of Southern Baja California, and 85 miles west of Guaymas, Sonora, Mexico. A well-kept harbor, constructed of smelter slag, is connected by piers with the adjacent smelter and warehouses, to facilitate the loading of blister copper and the unloading of general supplies, machinery, timber, and oil needed for the camp and plants. The company owns and operates three ocean-going steamers: One tanker for transporting fuel oil, which is purchased in San Pedro, Calif.; a freighter that carries the blister copper to the Tacoma smelter of the American Smelting & Refining Company, and timber on the return trip; and a second freighter for passenger and cargo service along the West Coast of Mexico.

The shortest route to Santa Rosalia is via the Southern Pacific railroad from Nogales, Ariz., U. S. A., to Guaymas, Sonora, Mexico; thence by boat to Santa Rosalia. The trip across the gulf, made in 40-ft. boats, is somewhat tedious and, depending on the weather, requires from twelve to forty-eight hours. Overland, Santa Rosalia can be reached by automobile from Mexicali, Mexico, over recently constructed trails. A plentiful supply of gasoline, food, water, and excavating tools are essential in making the four days' trip.

Little did Hernán Cortés and his hundred soldiers, inspired by Montalvo's *Las sergas de Esplandián*, dream when he discovered and explored the "Isla de las Perlas," as Baja California then was known, of the mineral wealth slumbering beneath the surface of the desert. The Boleo mines were discovered in 1868. According to a legend, a rancher of Santa Agueda, and his companions, while preparing their evening meal on a hearth made of the red and green balls, or *boleos*—fragments of carbonate capping then found in the alluvial gravel—noticed a bright green flame emerging from the fireplace. Curiosity prompted the rancher to take some samples to Guaymas, where the presence of copper minerals was detected. News of the discovery soon spread, and a steady migration of prospectors and miners started to this region. At that time the mines were worked by small companies in a primitive manner, and only ore ranging from 20 to 35 per cent copper was either shipped to Europe or to the smelter at Guaymas, owned by German interests. Exploitation on a large scale began in 1886 by the present company.

The climate at Santa Rosalia is subtropical and free of fevers. With the exception of several ranches maintained by the company for the purpose of supplying meat, vegetables, and milk, the surrounding country is a desert. The entire holdings of the company consist of 20,000 hectares of mining land and 598,000 hectares of grazing land. In normal times a population of more than 10,000 depends upon the operation of the property, the employees at the mines and smelter totaling 3,500.

The Boleo ore deposits are unusual in several respects, and similar deposits have probably not been discovered elsewhere in the world. The ore occurs in five separate flat beds, or *mantos*, similar to coal seams, which are composed of a clayey tuff resting between layers of coarse conglomerate and tuffs, on an andesite floor, as shown in the accompanying sketch. Beds Nos. 0, 2 and 4, with a copper content less than 1½ per cent, are not exploited. Ore mined from beds Nos. 1 and 3 comprises a varied series of copper minerals, with chalcocite and covellite as chief constituents, in combination with cobalt, zinc, manganese, and nickel. The minable ore is soft and resembles oil shale in color. Normally, it is broken with hand picks, powder seldom being employed.

In current operations the *mantos* are developed and exploited from four different mines, grouped around the

smelter, known as the Purgatorio, Rancheria, Santa Marta, and Providencia. A new unit, the San Luciano, about 16 km. south of Santa Rosalia, is being opened up and equipped with the necessary machinery. The ore from this mine will be transported over a wire-rope tramway to the storage bins at the Rancheria mine, and thence hauled in 6-ton railroad-type cars to the smelter. Exploration work is done with combination churn- and core-drilling machines. Several of the smaller mines in the Infierno district are worked by native leasers. Gypsum for smelting operations and lime for construction purposes are obtained from the company's own mines and quarries.

The surface plant at the four aforesaid mines is more or less standardized. Each mine is opened up by incline shafts that vary from 300 to 1,000 ft. in depth and connect with extensive underground workings. The ore is hoisted to the surface in small cars of 1,000-lb. capacity, which are discharged into a wooden receiving bin by locally designed gravity tipples. From this bin the ore passes onto slowly moving steel conveyors, where it is hand sorted. The ore, left on the conveyors, is discharged into large loading bins, and the waste, thrown on a second conveyor, is loaded onto cable-operated cars for disposal at the waste dump.

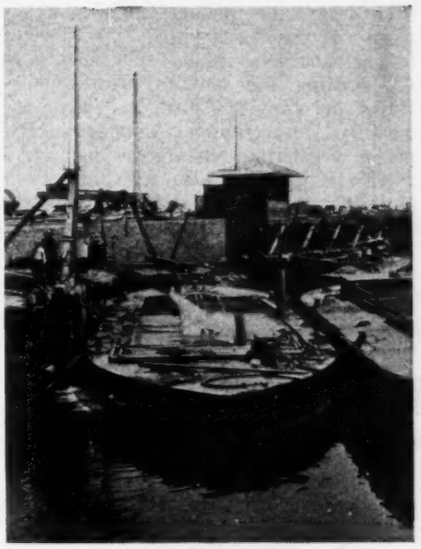
In hoisting mine cars to the surface through the incline shafts an endless chain, attached to the hoisting machinery, is employed. Underground, the cars, containing a small saddle with a slot large enough to accommodate a chain link, are fed to the moving chain by hand, but on the surface they are moved to the chain automatically. Two men and a hoistman supervise these operations. Water encountered on the lower levels is diverted into a general sump and raised to the surface by electrically driven centrifugal Sulzer pumps. Compressed air, furnished by small air compressors connected to a 2-in. pipe system, is required in but small quantities underground—chiefly for the I-R Jackhamer drills used for drifting—all other machinery being electrically driven. Portable fans and canvas tubing are maintained on the lower levels for ventilating the advance headings, raises, and chambers. Electric current at 380 volts is distributed at each mine through a network of insulated power cables strung along the tunnel walls in an elevated position. Drills, drill steel, and cars are repaired in well-equipped shops maintained at each mine. Small oil-fired Baldwin locomotives and 6-ton railroad-type cars are used for gathering and haulage of ore to the smelter storage bins. Underground, mules and ½-ton cars are employed exclusively.

The greatest difficulty encountered at Boleo is that caused by the broken character of the ground and the constant pressures involved. The deposit may well be compared with a mass of rubber, in which any perforation will close up gradually the moment the perforating instrument is withdrawn. Continuous effort is necessary to keep the drifts, raises, and shafts open and safe. Obviously, timber consumption is high. About 4,000,000 ft. of timber, at a cost of more than 670,000 pesos, was required to mine 300,000 tons of ore in 1930. The cost per ton of ore mined and delivered at the smelter bin averages 9 pesos, of which 2 pesos is charged to timber. Tonnage mined per man-shift ranges between 2 and 2½ tons. Timber 4 in. square and round timber 6 in. in diameter are used exclusively underground. For lagging, split caps and salvage timber are employed.

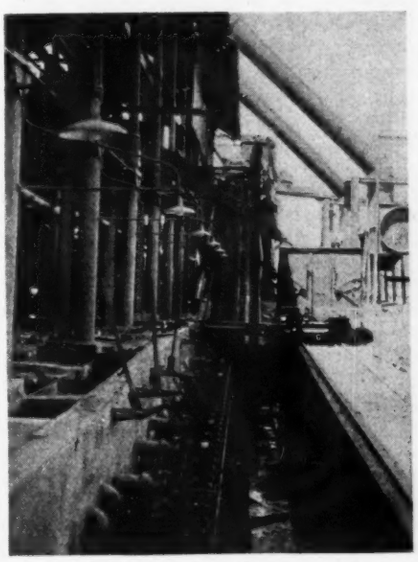
Mining operations, owing to the flat and large beds and to 10- to 15-deg. dips of the seams, are similar to the long-wall and chamber methods practiced at coal mines. Of more than ordinary interest is the complete mechanization of ore transportation from the face to the loading station, by means of light, electrically driven belt conveyors, installed along the entire face and on the sublevels. The 20- and 26-in. belt conveyors, manufactured by The Mining Engineering Company, Worcester, England, are built in 6-ft. sections and are equipped with automatic couplings that facilitate shortening and lengthening of the conveyor, according to requirements. The rubber belts can be adjusted in a like manner. Specially designed self-adjusting locks and chains are provided to anchor the conveyors to sturdy posts along the face and drifts. Less than two hours is required by eight men to move a conveyor to its new position. The life of a rubber belt is about one year. Experiments have also been conducted with electrically driven shakers, which were found unsatisfactory from an operating standpoint, because the noise they produced prevented workers from hearing ground movements.

Prior to the installation of conveyors, small mine cars were used at the face. This method of transport, owing to the large number of cars required and the difficulties encountered in car distribution, affected stoping operations detrimentally. The work was found to be costly and inefficient. At present 90 per cent of all the ore produced is transported on conveyors. In smaller beds, cars are still employed.

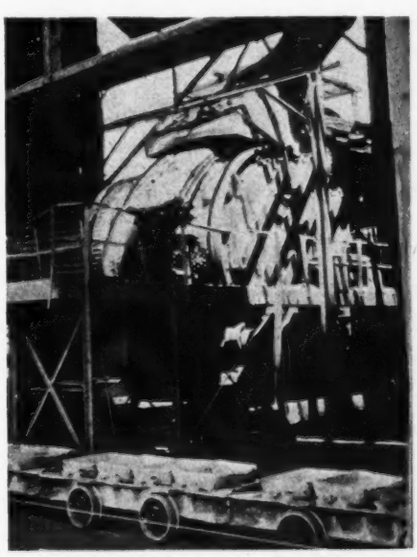
All mining operations are performed on contract. A 7-ft. section of the working face is allotted to each contractor, who, besides breaking and shoveling the ore onto the conveyor, also does his own timbering. Timbering must be carried close to the face because of the broken character of the ground. Waste, thrown back of the conveyor, serves as filling for the mined-out area, which is supported by light cribbing and posts. Average earnings



Loading granulated slag into a barge



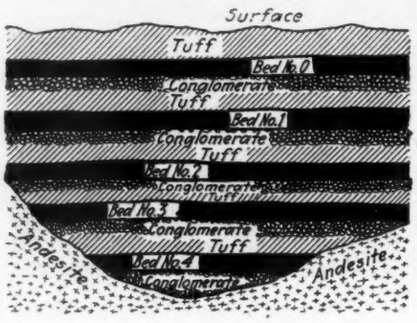
Granulated slag launder alongside of reverberatory building



Converter and casting molds

of a contractor amount to about 5.50 pesos a day. Mounted I-R Jackhamers and $\frac{7}{8}$-in. hollow steel are used for drilling the 10-hole drift round. Posts and caps are 8 ft. and 6 ft. in diameter, respectively. In blasting, 40 per cent gelatine dynamite is used. A 20-in. gage and 16-lb. rails are employed in the haulage drifts.

From the loading bins of the various



Section of the Boleo ore deposit

mines, the coarse and fine ores are delivered in 6-ton bottom-dump cars over an elevated track system to separate bins, with a total capacity of 2,000 tons, at the smelter. The smelter flowsheet is as follows: Automatic feeders control the flow of coarse ore onto a pan conveyor that discharges to two hammer crushers, driven by 80-hp. motors equipped with magnetic clutches. The $\frac{1}{4}$-in. product of the crushers is raised by three bucket elevators and discharged into four wooden storage bins. Fine ore passes direct from the fine-ore bins to these storage bins. The ore is then delivered by conveyors to four 7x70-ft. Allis-Chalmers rotary dryers, each of which discharges through a sampler into a dry-ore receiving bin. Ore from these bins is fed to six automatic mixers, which prepare the feed for six 18x72-ft. reverberatory furnaces, equipped for side charging.

The reverberatory furnaces are of the usual silica-brick construction, and have a capacity of about 250 tons of solid charge a day, using about 1.1 bbl. of oil per ton, blown in with 2-lb. air. When using Dubbs oil, 0.92 bbl. is required per ton of ore. The five burners are arched, those at the center being lower than those at the ends, thus making the shape of the bed of the flame conform to the way the charge lies in the interior of the furnace. A superimposed belt conveyor and tripper constitute the feed mechanism. The charge is fed continuously from two 42-ft. sheet-iron troughs attached to the furnace wall by fourteen tubes. One man per shift is required to supervise the charging of the four furnaces that are usually in operation. Slag is tapped at the uptake end, and matte at a point 48 ft. from the bridge wall. All furnaces are equipped with Stirling waste-heat boilers, which deliver steam at 150 lb. to the power house. Two of the four dryers are oil-fired and two utilize the waste heat from one reverberatory unit, controlled by a special bypass in the flue. Free moisture in the ore, averaging 28 per cent, is reduced to 4 per cent.

Smelting of the charge, owing to its low-sulphur content, presented many difficulties. Prior to 1922, imported pyrites was added to the charge as a sulphurizing agent. This was costly and often resulted in unsatisfactory slags. Elaborate research and experimental work led to the perfection and adoption of the method that is employed at the property today.

Coal is added in precalculated amounts to sulphurous ores, gypsum, of which the company has an abundant supply, and iron being added to ores of the oxidized variety. The coal and gypsum are crushed to $\frac{1}{4}$ in. in a hammer mill, and reduced to 150 mesh in an Allis-Chalmers rod mill. Oil, introduced at the feed end of the mill, is used as a binder, to avoid dust losses. Matte ranges from 63 to 65 per cent copper. Slag averages: copper, 0.50 per cent; silica, 50.20 per cent; and aluminum, 14.86 per cent.

Matte from the reverberatory furnaces is collected in cast-iron ladles, and conveyed by crane to two Peirce-Smith converters. Converter slag is returned to the reverberatory furnaces. Each converter has a capacity of 22 tons, and contains seventeen $1\frac{1}{2}$-in. tuyères, through which air is delivered at a pressure of 14 lb. Flux consists of silica and reverberatory slag. The matte is blown into blister copper, assaying 99.50 per cent copper, in about five hours. Stationary hoods cover the mouth of each converter and convey the gases to the flue that leads to the steel stack. Blister copper from the converters is discharged into ladles, and poured into the molds of a locally made casting machine. From the casting floor, the blister cakes are conveyed to the stockyard, whence they are shipped to the Tacoma smelter or Europe.

The reverberatory slag is granulated by sea water, obtained by gravity from three elevated tanks, fed by seven automatically controlled Sulzer pumps. Sheet-iron and concrete flumes deliver the slag to specially designed barges, which dispose of their cargoes at sea.

The power house is adjacent to the converter building, and contains modern power and air-generating engines and auxiliaries. Fuel oil is stored in two tanks, having a total capacity of 60,000 bbl. Generated power is distributed over a network of power lines to the ranches, mines, and settlements, at 22,000, 5,000, 380, and 110 volts. Modern shops, accessible by narrow-gage tracks, and a sawmill are maintained at the smelter.

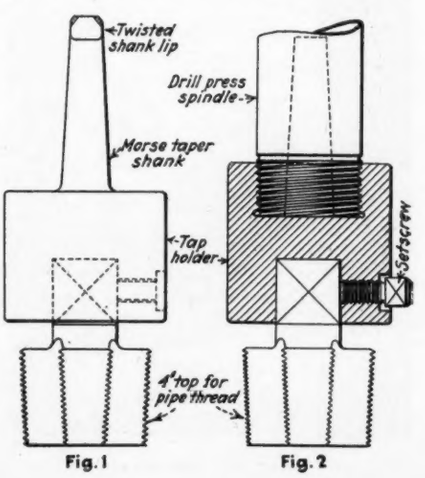
Potable water is obtained from a natural artesian well, about 20 km. southwest of Santa Rosalia. To safeguard the population against typhoid fever, water purifiers are maintained at Santa Rosalia and at the villages. More than 3,000 well-constructed dwellings are available for employees. Each of the four principal mining centers, as well as Santa Rosalia, includes a large school house, recreation halls, and an emergency hospital, with a staff of physicians and nurses. A modern X-ray department is maintained at the main hospital at Santa Rosalia. Excellent results have been obtained, and keen interest is shown, in accident prevention and safety endeavor.

In conclusion, grateful acknowledgment is made to A. Nopper, general manager, and to Messrs. Siffre, Bellebouche, Mussio, Mahieux, Perrin, and Quintanilla for their hospitality and the courtesies shown to me during a recent visit to Santa Rosalia, when the information presented in the foregoing account was obtained.

■ ■

Tool Holder for Tapping Roaster Rabble Arms

CONTINUOUS trouble was experienced in the machine shop of the United Verde Copper's smelter, at Clarkdale, Ariz., when tapping the 4-in. ventilating holes of the roaster rabble arms. This operation is performed in a large radial drill press, using a special tap holder equipped with a Morse taper to fit the hole of the drill press spindle, as illustrated in Fig. 1. The device worked satisfactorily if no excess of pressure was exerted; otherwise the taper lip was invariably twisted off, causing a shutdown and delay. This difficulty was remedied by threading the end of the drill-press spindle and by constructing a new tap holder, the details of which are shown in Fig. 2.



Cost of Shaft Sinking

Morris J. Elsing

OF ALL workmen in mines, I should select shaftmen as the most expert. Their task is the hardest, most dangerous, and the most difficult. They customarily work under high tension, whether sinking or repairing a shaft. Usually they are large men, as only occasionally can a small man stand the strain of the high-speed work required. Besides being large, their work also requires that they be agile, quick, and, above all, sure of every move they make. An awkward man in a shaft becomes a danger not only to himself but to his fellow shaftmen. There must be a fascination about the work, because in any large mining district a certain group which follows shaft sinking is usually to be found.

Of all the shaftmen I have known, I shall always consider John P. Harrington as the best of all shaft contractors in the Southwest, and I respectfully dedicate this discussion on shaft sinking to his memory. He is remembered as Jack Harrington, but still better as the "Slasher." He was a big, powerful man, and his nickname aptly describes his main characteristic, which was speed. Most of his life he did nothing but sink shafts all over the Southwest. His records include such statements as "be it said to the honor of Jack Harrington and the Inspiration Copper Company at Miami, Arizona, that under his direction 1,400 ft. of six-compartment shafts (12 ft. 4 in. by 16 ft. 8 in. in the clear) was completed in ten months and 209 ft. of this in 28 days." Later I shall describe a shaft he sank under my supervision in the Bisbee district. While doing this job, he met his death in the same way he lived—too much speed, this time in an automobile.

Mining literature contains too few records of the unit costs of shaft sinking, but those available are probably more accurate than some other unit costs, as for example drifting or raising. This is owing to the fact that the job is usually a big undertaking and special consideration is given it and provisions are made to obtain accurate costs. Then, also, the shaft is often an independent operation, and costs are directly obtained rather than by making arbitrary segregations.

Shaft sinking is divided into three distinct operations—(1) drilling and blasting; (2) mucking; and (3) timbering. The cost per foot depends upon the size of the shaft, the character of the timbering, the hardness of the formation, and whether the shaft is wet or dry. Whether the shaft is incline or vertical is not so important. Mucking in an incline shaft is a little more difficult, but timbering is often easier, and less timber is required, which usually offsets a higher cost for mucking.

The presence of water cuts down the speed of sinking a shaft in rock formations and consequently raises costs, more than any other condition. Aside from the cost of pumping, the cost of all operations will be higher because of the handicaps resulting from a big flow of water. The size of a shaft largely determines its cost per foot, inasmuch as mucking is a large item and for a large shaft a correspondingly large amount of timber is required. The hardness of the ground is not so important. Direct labor costs under normal conditions can be roughly divided thus: 55 per cent for mucking, 25 for drilling and blasting, and 20 for timbering. Therefore, the hardness of the ground does not affect labor cost importantly. The breaking characteristics have an important effect on powder cost per foot, but this is small when compared to labor cost. In some cases, of course, the occurrence of very soft ground or very hard ground does have an important bearing on costs per foot, but such instances are unusual. The rate of mucking is somewhat affected by the nature of the rock broken, as certain classes of material can be more easily shoveled than others. On the whole, the most important factors influencing costs are the wetness or dryness of the shaft, its size, and the character of the timbering.

Table I—Cost and Quantity of Shaft Timber

Three compartments 4 x 5 ft. in the clear. Sets 5 ft. c. to c.

	Board Feet		
	8x8 In.	10x10 In.	12x12 In.
Lagging, 2 in.	318	318	318
Posts	192	292	400
Plates	268	453	676
Miscellaneous	272	345	408
Total per set	1,048	1,048	1,802
Per foot of shaft	210	282	360
Cost per foot of shaft	$8.40	$11.28	$14.40

In Table I, data are given to show the importance of the character of timbering used. The shaft is assumed to have three compartments 4x5 ft. in the clear, to be lagged on the outside with 2-in. plank, and to have sets spaced 5 ft. from center to center. Timber is assumed to cost 4c. per board foot and the shaft set to be of conventional design. The amount of timber required and the cost of it per foot of shaft are shown for different sizes of timber.

In an incline shaft of equal size in firm rock the timber required would be perhaps $1.50 or $2 per foot of shaft and would consist of stulls and stringers every 10 ft. and track ties and ladders and lining boards on the manway side.

The cost of shaft sinking in various parts of the United States is shown by published cost statements presented in the following:

At the Tri-State District mine referred to as "Mine No. 2" in I.C.6121[1], a 5x7-ft. shaft was sunk 260 ft. Of this 100 ft. was through shale, which was drilled by augers and crib-timbered. The remaining 160 ft. was in limestone, which was drilled with jackhammers and untimbered. The shaft was dry. With fourteen 5-ft. holes, an advance of 4.5 ft. was made per round with 50 lb. of powder in the limestone. Costs are given in Table II.

The total cost of the work listed in Table II was actually $20.08 per foot, but this included certain equipments cost for "derrick" and for incidentals which have been eliminated. Such a shaft is known as a field shaft and is commonly used in the Tri-State District.

This shaft is little more than a winze, most of which is untimbered. It is in no sense comparable with the cost of other shafts presented. The case is cited because it is typical of a large and important district.

The work of sinking the American Eagle shaft[2] by the Stratton Cripple Creek Mining & Development Company, Victor, Colo., involved putting down a 7x17-ft., three-compartment shaft, timbered with 10x10, 8x10, 6x10, and 4x10-in. timbers. Sets were spaced 6 ft. center to center. Oregon fir cost $47.25 per 1,000 b.ft.; yellow pine, $38.42. Two shifts were worked per day. Two hours were required to drill the round, and one hour was required to blast. Each shift mucked, drilled, and blasted a half round. Twenty-five tons was mucked

Table II—Cost of Sinking at Mine No. 2 Tri-State District

Labor	Cost per Foot
Hoistmen	$2.33
Shaftmen	5.07
Labor, sawing, cribbing	0.15
Explosives	1.57
Insurance	0.40
	$9.52
Contractor's profit	1.95
Compressed air	0.90
Supplies	6.49
	$18.86

This is the third of a series of articles on the cost of mining in the United States.

[1] I. C. 6121. Throughout this article "I.C." refers to the U. S. Bureau of Mines Information Circulars.

[2] *E. & M. J.*, Oct. 23, 1926.

Table III—Cost of Sinking American Eagle Shaft, Victor, Colo.

Contractor		Cost per Foot
Labor (4 men @ $7)		$16.21
Explosives		
Powder	$3.68	
Connecting wire	0.02	
Delay electric fuses	0.88	4.58
Carbide		0.16
		$20.95
Company		
Bolts (¾ in. x 7 ft. 3 in.)		0.78
Timber		7.98
Air line, 3 in.		0.22
Ladders (16 ft. @ $3.20 each)		0.26
Landing (every 12 ft.)		0.05
Guides (4 x 6 x 24 in.)		0.60
Lagscrews (¾ x 7 in.)		0.02
Bell line (¾ in.)		0.22
Machine-drill repairs		0.25
Auxiliary hoisting (2 men @ $5)		
Air $5 per shift		5.59
Timber framing		2.00
Total company		$17.97
Total cost		$38.92

per half round in five hours, there being fifteen holes to the half round. The rock was well-sheared breccia which broke well. Powder cost was $15.25 per 100 lb. Five sets of timber were hung and placed in one shift, and were blocked, lagged, and lined by the succeeding shift. A total of 608 ft. of shaft was sunk. The shaft was vertical. Rate of advance was 3.71 ft. per 24 hours. The shaft was sunk during the early part of the war. Costs are given in Table III.

The cost given in Table III does not include the shaft contractor's wages nor his profits. Supervision is also lacking. The figure should also include a hoisting charge from the bottom level to the collar of the shaft, which is in addition to the auxiliary hoisting from the bottom of the shaft. Insurance also is a legitimate and usual charge. No charge for drill-steel sharpening and replacement appears to have been made.

Summarizing these additional charges, they might be as follows: Contractor's wages and profits, $9.40 per foot; supervision, $1.50; hoisting waste, $4; insurance, $1.10. Total, $16 per foot. This would give a total cost of $54.92. Such a cost is remarkably low and possible for this size shaft only with good ground conditions and efficient management.

In sinking at the Ajax mine[3], Cripple Creek, Colo., a vertical shaft was put down 502.2 ft. in granite—that is, from 1,481.3 to 1,983.5 ft. It had three compartments, the over-all dimensions being 6 ft. 2 in. by 15 ft. It was timbered with 10x10-in. timber. Four drills were used, sinking proceeding on two shifts. Costs were raised by World War conditions. They are given in Table IV.

The cost in Table IV does not include the items chargeable for supervision, but otherwise is very complete. It is higher than the cost of sinking the American Eagle shaft just mentioned, but nevertheless is remarkably low.

In *Engineering and Mining Journal* of March 24, 1930, the work of deepening the McPherson shaft of the Tennessee Copper Company, at Ducktown, Tenn., was described. An advance of 57 ft. was made. The shaft is vertical and has three compartments. It is 8.5x19 ft. in cross-section, and is timbered with 8x8-ft. timber. Advance per round is 5.5 ft., 40 to 48 holes being used. The rock is medium to hard graywacke, schist, quartz, and diorite. Costs for October, 1929, are given in Table V.

Table IV—Cost of Shaft Sinking, Ajax Mine, Cripple Creek, Colo.

Labor	Average Wage	Cost per Foot
Machinemen	$5.25	$6.51
Muckers	4.50	6.47
Timbermen	5.25	5.11
Sinking hoistmen	4.13	3.76
Shift bosses	5.00	1.50
Machinist and blacksmith	4.50	0.49
Topmen and skippers	4.00	1.19
Pipemen and repairs	4.00	0.74
		$25.77
Materials		
Dynamite @ $19.42 per 100 lb.		4.02
Fuse $6 per 1,000 ft.		0.86
Caps $1.75 per 100		0.24
Timber $28.33 per 1,000 b.ft.		6.57
Machine drills (two new)		1.79
Pipe		1.53
Iron and steel		1.01
Miscellaneous		0.91
		$16.93
Service Charges		
Hoisting waste to surface, 60c. per skip		$5.62
Air, $2 per drill		2.64
Air sinking hoist, $2.50 per shift		2.14
Sharpening steel, 10c. per bit		4.18
		$14.58
Total cost per foot		$57.28

Table V—Cost of Deepening McPherson Shaft, Tennessee Copper Company, Ducktown, Tenn.

	Cost per Foot
Labor including $14 bonus	$41.02
Material	14.63
Explosives	5.80
Air drill expense and power	4.09
Total	$65.14

Table VI—Cost of Sinking No. 5 Shaft United Verde Copper Company, Jerome, Ariz.

	Cost per Foot
Labor	$38.41
Explosives	4.43
Timber	5.39
Compressed air	5.83
Supplies and repairs	6.10
Total	$60.16

Cost of sinking United Verde Copper Company's No. 5 shaft[4] at Jerome, Ariz., is given in Table VI. The shaft is 7x18 ft. in cross-section and was sunk 550 ft. from the 1,950 to 2,500 level. It is timbered with 8x8-in. Oregon pine, the sets being 6 ft. center to center. Thirty-eight 5-ft. holes gave an advance of 4 ft. per round. The small amount of water was hoisted in buckets. The ground was tough quartz porphyry. Lagging cost $27.30 per 1,000 b.ft. Oregon pine cost $45.75.

The costs in Table VI include hoisting from the bottom of the shaft to the 1,950 level, but not from the latter point to the surface. The cost of waste disposal must therefore be added to the figure given. The timber cost seems low with Oregon pine at $45.75, but the shaft may not have been tightly lagged.

Table VII—Comparison of Cost of Blasting With Ordinary Fuse and Electric Detonators, Bisbee Queen Shaft

Method	Depth, Ft.	Cost per Foot—Powder	Caps and Fuse	Total
Fuse and caps	290	$4.44	$0.92	$5.36
Electric detonators	491	4.62	1.14	5.76

Table VIII—Cost of Sinking Bisbee Queen Shaft, Bisbee, Ariz.

Labor	Cost per Foot
Shaft	$30.93
Blacksmithing	2.07
Timber framing	2.84
Hoisting	2.77
Explosives	5.49
Timber	7.60
Power	2.39
Insurance, liability	2.15
Miscellaneous supplies	7.40
Auto	1.31
Office and general	2.06
Preliminary work	2.14
Total	$69.15

In 1927 I undertook to sink an 800-ft. shaft in the Bisbee district, Arizona, for the Bisbee Queen Mining Company. Jack Harrington, already mentioned, having just finished a shaft job in the Oatman district, made the successful bid on the Bisbee Queen shaft. Installation of the surface plant was completed and sinking operations started Feb. 21, and the shaft was finished June 15, 1927.

The shaft had three compartments, each 4x5 ft. in the clear and timbered with 8x8-in. timber. It was sunk 823 ft. in fairly hard, unaltered limestone with an occasional hard, siliceous bed. No water was encountered. The contract price for labor and explosives was $40 per foot. Harrington paid his crew $8 per shift, or $9 if they made 200 ft. per month. The shaft was 8x17 ft. in dimensions, and the crew consisted of seven men underground, one man of whom was a jigger boss. Harrington considered one man was an extra, but he figured that it was more economical to carry one extra on his payroll so that his crew would not be short if any one laid off for a shift. Five drills were run during drilling work, which allowed two men to be used as helpers. During mucking, one man relieved the others.

The average round consisted of 28 holes and broke 5 ft. The first part of the shaft was sunk by blasting with the ordinary fuse and caps, but at a depth of 290 ft. electric blasting was adopted. The difference in cost is noted in Table VII. Cost of sinking is given in Table VIII.

The shaft was situated about 4 miles from Bisbee, and the company supplied automobile transportation for all the men. The rest of the time the truck was busy delivering miscellaneous sup-

[3] *E. & M. J.*, Aug. 15, 1925.
[4] A.I.M.E., Vol. 66.

Table IX—Sinking Costs, Saginaw Shaft
Calumet & Arizona Mining Company

	Cost per Foot
Shaft labor	$23.48
Shop labor	1.18
Supplies	8.68
Framed timber	8.09
Air drills	6.62
Hoisting	6.48
Top landing	2.81
General surface	3.54
Supervision and engineering	1.83
Miscellaneous	0.91
Insurance	1.30
Total	$64.92
Installation Costs	
Headframe (erection only)	$4,630.11
Hoist (old)	00.00
Hoist, moving, erection and repairs	4,909.81
Motor	3,471.67
Sheaves, cages, bells	1,678.21
Air and water lines	1,006.40
Ventilation equipment	890.95
Surface buildings and roads	2,993.47
Power line, switchboard and tower	4,988.90
Compressor foundations and repairs	1,671.06
Total	$26,240.58
	Cost per Foot
Installation and equipment	$31.25
Shaft repairs, 870 level	12.12

The above equipment costs do not include the costs of the steel headframe or hoist, which were obtained from the Irish Mag mine, nor the compressor, which was taken from the Junction mine.

Table X—Cost of Sinking Boras Shaft

	Cost per Foot
Labor	$28.77
Insurance	2.31
Auto	1.46
Power	3.51
Repairs	2.39
Timber	5.25
Supplies	14.65
Miscellaneous	0.98
Total	$59.32

plies. Insurance was at the rate of 5.5 per cent of the payroll. Electric power was purchased at an average of about 2c. per kilowatt-hour. Powder cost $16.50 per 100 lb. and timber $30 per thousand board-feet delivered to the mine. The greatest advance made in any one month was 235 ft.

In 1930, the Saginaw shaft of the Calumet & Arizona Mining Company, Bisbee, Ariz., was sunk from the 1,000 level to the 1,800 level, a distance of 837 ft. In size it is 8x18 ft., which when concreted will give three compartments 5 ft. by 6 ft. in the clear. Table IX gives the cost per foot for doing this work.

In 1922 the Boras Leasing Company, Bisbee, Ariz., sank the Boras shaft from the 700 to 1,100 level. This shaft was 8x11 ft. and timbered with 8x8-in. timber. The ground was medium hard limestone. Mexican labor was employed. Complete costs are submitted in Table X.

Cost of sinking the No. 5 shaft of the Magma Copper Company, Superior, Ariz., in 1928, from the surface to the 2,531-ft. level, as given in I.C.6168, is presented in Table XI. This shaft is 8x21 ft. in dimensions and has four compartments, 4x5 ft. in the clear. The rock is diabase. Timber used was 10x12 in. Actual drilling required was 5.5 hour per round.

A summary of the costs of the shafts already discussed, with other shaft costs, is given in Table XII.

If an advance of 200 ft. per month in medium hard ground be assumed, the costs given in Table XIII are attainable in a three-compartment vertical shaft timbered with 8x8-in. timber, with over-all dimensions 8x17 ft.

The figures given in Table XIII cover all costs for supervision and general expense. Miscellaneous supplies include machine-drill repair parts and steel and all other supplies. The estimate is made for a shaft 1,000 ft. deep. Greater depth will add slightly to the cost. A moderate amount of water will add 10 to 15 per cent to the cost. The above cost is believed to apply to a wide range of ground hardness. Cost due to harder ground can be partly offset by placing sets on 6-ft. centers. I believe the cost of sinking such a shaft will be closely the same all over the United States, except in localities of great isolation, and that wages or efficiency of labor is not so important as efficiency of management which provides an economical surface plant and proper tools and other equipment.

Size and Cost of Shafts. I have already pointed out that the three most important factors which determine the cost of a shaft are water, size of shaft, and character of the timbering. The cost of shafts of different sizes does not vary in the direct ratio to their size. Mucking, which comprises about 55 per cent of the total labor, is directly proportional to the size of the shaft. An increase of one-third in the size of the shaft requires only about 20 per cent

Table XI—Sinking Costs, No. 5 shaft
Magma Copper Company

	Cost per Foot
Jiggers @ $6 base	$3.85
Shaftmen @ $5.50	16.39
Toplanders @ $4.13	2.96
Trammers @ $4.13	0.58
Sinking bonus	29.76
Explosives	4.12
Timber material	14.76
Timber framing	2.08
Compressed air	2.61
Total	$77.11
Miscellaneous	3.73
500 sinker hoist	2.37
2,550 sinker hoist	0.46
No. 5 hoist	3.69
Pumping and drainage	7.99
Air and water lines	2.56
Power lines	2.71
Ventilation	1.46
Telephones and signals	0.77
Dump	1.67
Total	$104.52

Table XIII—Estimated Cost of Sinking 8x17 ft. Vertical Three-compartment Shaft

Labor	
Shaft	$30.00
Blacksmithing	2.00
Timber framing	2.75
Hoisting	2.75
Explosives	5.50
Timber	7.50
Power	2.25
Insurance	2.00
Miscellaneous supplies	7.00
General expense	3.25
Total	$65.00

Table XII—Summary of Cost of Shaft Sinking

Location	Reference	Size, Ft.	Cost per Foot	Remarks
American Eagle	*E.&M.J.*	7x17	$38.92	1916. Incomplete cost. See text; 4x10—10x10-in. timber; 3 compartments.
Ajax Mine	*E.&M.J.* Aug. 15, '25	6x15	57.28	1916. See text; 10x10-in. timber; 3 compartments; 502.2 ft. in granite.
McPherson, Ducktown, Tenn.	*E.&M.J.* Mar. 24, '30	8.5x19	65.14	October, 1929; 3 compartments; 8x8-in. timber.
United Verde, No. 5 Shaft, Jerome, Ariz.	A.I.M.E. Vol. 66	7x18	60.16	1920. Almost dry. Tough quartz porphyry; 8x8-in. timber.
Bisbee Queen, Bisbee, Ariz.	Author	8x17	69.15	1927. Complete, all overhead included. Medium hard limestone; 3 compartments; 8x8-in. timber.
Boras Shaft, Bisbee, Ariz.	Author	8x11	59.32	1922. Complete, all overhead. Medium hard limestone; 2 compartments; 8x8-in. timber.
Argonaut, Calif.	I.C. 6311	9x17	45	Incline shaft. Labor only; 3 compartments. Timber 10x16 to 16x16-in.; shale.
Magma No. 5, Superior, Ariz.	I.C. 6168	8x22	104.52	1928; 4 compartments; 4x5 ft. Shaft sunk 2,531 ft.; diabase; water.
Engels Copper Company	I.C. 6260	7x17	60.49	1928. 50 per cent timbered; timber 102 b.ft. per foot. Hard diorite.
Cananea, Mexico	I.C. 6247	8.5x22	74.18	Colorada shaft; labor $43.46; supplies, $27.26; power, $2.44; sundries, $1.02.
Cananea, Mexico	I.C. 6247	8.5x28	113.14	1925. Capote shaft. Very detailed statement. Water
North Star, Grass Valley, Calif.	A.I.M.E. T.P. 324	8x17	100.00	Average for 2,000 ft. shaft. Total price with preparation work, $118.38. Contract price, labor and explosives, $65.
		7x15	83.73	1926-1927. Incline shaft. No. 2 shaft. Little timber; 32 holes; 6.5 ft. advance, 20 gal. water gave trouble because shaft over 6,000 ft. deep. Contract price, $37.50, including labor.
United Verde, Jerome Ariz.	*E.&M.J.* May 2, '30	7x14	52.70	Medium quartz porphyry; 750 ft. from 2,400-3,150 level; powder excluded. Electric primers, $5.20; labor, $31.85. Water, 5,000 gal. per hour.
Pecos Mine, New Mexico	I.C. 6368	7x21	110.25	1930; 10x10-in. timber. Labor, $68.71 per foot, supplies, $41.54.
			119.01	1927-1929 inclusive. Labor, $74.821; supplies, $44.19. Granite, diorite, schist.
Eureka-Asteroid, Gogebic Range	I.C. 6348	14x21		Labor, $60. Steel timber.
Calumet & Ariz., Bisbee, Ariz.	Personal	8x18	64.92	1930. For 837 ft. from 1,000 to 1,800 level.

more timber. An extra compartment, giving a shaft an additional length of 6 ft., does not require a proportionately greater number of holes and powder. Almost all items other than mucking do not increase the cost of the shaft in proportion to its size. Given equal ground conditions and similar timbering, an increase in the size of the shaft will increase the cost by approximately 60 per cent of the increase in size. In other words, if the estimated cost of sinking a three-compartment shaft is $65 per foot, and it is decided that the shaft shall be sunk with an additional compartment of equal size, the cost will be $78 per foot for the four-compartment shaft. This ratio of cost to size also applies to conditions where width as well as length are increased.

By applying the foregoing ratio to the cost of the shafts presented, a closer relationship in cost is found. However, costs of shaft sinking vary more than any other operation about a mine. The main reason for this is the fact that shaft sinking is a highly specialized work, and unless a company is more or less constantly doing it the best shaft men are not in its organization. The high wages usually paid attract the best men to some other district where this class of work is going on.

Low costs nearly always accompany speed, as the overhead organization is always large in comparison to the underground crew. A hoisting engineer is required on each shift, and at least one topman. When speed is attained, these costs and other fixed expenses can be spread over a larger footage. High speed is possible only when the most expert shaftmen are employed. In one of the largest Arizona camps the two most recent shafts were sunk under contract and about 90 per cent of the shaft crew were imported.

For shaft work the normal wage is about $1 more per shift than is received by miners. The expert crews referred to earned from $8 to $9 per day. The results, however, justified the higher wage.

Summary. The costs of the American Eagle, Ajax, McPherson, the United Verde No. 2, Bisbee Queen, Boras, and Magma shafts vary from $54.92 to $104.52. By analyzing conditions under which these shafts were sunk and their cost per foot one finds that a closer similarity of cost exists than at first appears, and where a cost is different there is an apparent reason for it. The first five shafts mentioned vary from $54.92 to $69.15. In the sinking of the American Eagle shaft ($54.92 per foot), certain overhead charges were estimated and added to the direct cost. These may be a little low. Any additional difference can be accounted for by the character of the ground. Drilling required but two hours.

In respect to the Ajax shaft ($57.28 per foot), no charge is given for supervision, which would add about $2 per foot. McPherson shaft ($65.14 per foot) corresponds closely to the estimated cost of $65 per foot. United Verde No. 5 shaft ($60.16 per foot) is not a complete cost, as it does not provide for complete hoisting and waste disposal. Bisbee Queen's cost ($69.15) is possibly a little high because of an inventory account for extra drill steel and a charge of $2.15 is made for liability insurance which is not included in the other costs. In regard to the Boras shaft ($59.32 per foot), I should say that this is a two-compartment shaft and that when allowance is made for size on the basis already suggested, the cost will be a little high, perhaps because it was driven in hard limestone.

The Magma shaft ($104.52 per foot) is larger and deeper than any of the others and water was encountered in sinking it. Because of this fact, certain additional charges were incurred which account for the most of the increase. These include extra large expenses for hoisting and $7.99 per foot for pumping, power lines, and other miscellaneous expenses. The timber used was 10x10-in. and the cost per foot for timber ($14.76) was double that of most of the three-compartment shafts. If allowances and deductions are made for these costs, the Magma cost will not be found out of line.

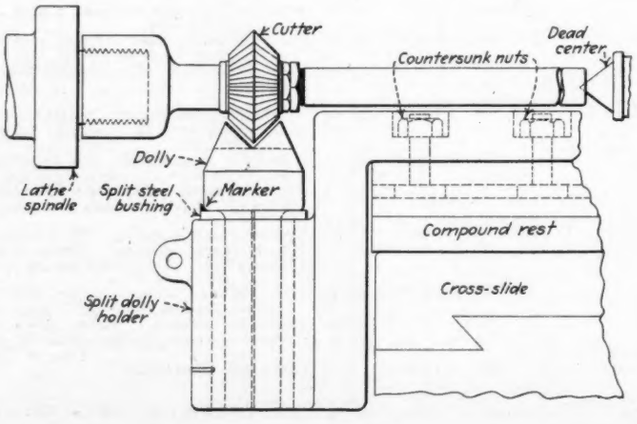
Wages paid in the different shafts varied from $5 to $9 per shift. The total cost of labor per foot is much closer than this ratio, and I am of the opinion that the higher wage is in every way justified by the results obtained. Efficiency of management is more important than efficiency of labor, as is apparent from the study of all mining costs.

Study of the cost of shaft sinking leads to the conclusion, already given, that a three-compartment shaft sunk in medium hard ground without water and with 8x8-in. timber will cost under present conditions about $65 per foot.

■ ■ ■

Milling Drill-Sharpener Dollies in a Lathe

INFERIOR drill bits, caused by worn drill-sharpener dollies, have a detrimental effect on the life of machine drills and drilling operations in general; if precisely forged bits are to be maintained, the dollies must be periodically exchanged or reconditioned, writes F. R. Kennedy, master mechanic, of the Old Dominion Company, at Globe, Ariz. The method employed at most machine shops is to anneal the dollies and rectify the worn surfaces in the shaper, or by a hand file if no machine is available. Both methods are unsatisfactory on account of the time and money wasted. A recent improvement is the milling of dollies in a lathe, as illustrated in the accompanying sketch. One end of the arbor containing the factory-made cutter is screwed on the lathe spindle, and the opposite end is supported by the dead center of the lathe. The dolly rests in a specially designed split holder of mild steel, fitted with a split steel bushing and a tension bolt, and fastened to the compound rest by two countersunk bolts. A small marker on the top of the bushing simplifies the adjustment of the dolly after each cut, so that it may be done in a few minutes. Once adjusted the compound rest remains stationary, and the cross-slide is used only to advance the worn dolly to the revolving cutter.



Exploration Methods and Costs at a Colorado Zinc Mine

Howard N. Lary

Accurate and detailed records of both deep-hole and diamond drilling, maintained over a period of six years, provide information valuable to the mining engineer interested in determining suitable prospecting methods for various types of orebodies.

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DEEP-HOLE drilling, as a method of discovering and outlining orebodies, started at Gilman in October, 1924. Drilling operations were on a half-time basis until May, 1928, when requirements necessitated full-time operation of the one drill then in use. With the resumption of mining operations in October, 1929, one drill was found to be inadequate, and two additional outfits were purchased, one in January, 1930, and the other in April of the same year. These have been run continuously on a one-shift basis. The drills are Model 34 Turbo drifting machines, manufactured by the Gardner-Denver Company.

With each new drill a complete outfit of accessories was purchased. This consisted of two 3½-in. x 7-ft. single-screw columns; one 3½-in. bar, 4 ft. long, with a 3½-in. saddle; 60 rod couplings, 1¼ in. in diameter; 27 detachable bits, with ⅛-in. changes, ranging from 2¼ to 3¼ in.; one water swivel and lugged shank; and 50 ft. of special ¾-in. high-pressure water hose, with fittings. Drill rods are made at the plant from 1¼-in. hollow round drill steel. Replacements, except those of the machines themselves, are usually made from material on hand.

The ore at Gilman occurs as a massive sulphide deposit in limestone, with a shale or quartzite back. It varies from a porous but firm, hard ore, which will stand without timber support, to a soft, sandy ore that has the same mineralogical character but is not firm, and caves easily. Particle size of the soft ore ranges from sand to boulders. In the waste surrounding the orebodies, the same conditions usually prevail. Country rock beyond this surrounding waste is essentially dolomite, with varying smaller amounts of shale, quartzite, and chert. Drilling in or near the sulphide orebody is usually fast, whereas away from the ore it is comparatively slow. Such a variety of drilling conditions has led to several changes from the equipment originally employed.

Rod breakage and consequent fishing have been the source of most of the difficulty experienced in deep drilling. With few exceptions, the breaks have occurred at the base of the threads on the rods, owing probably to strains set up in the rods by local changes in direction of the hole. This trouble has been reduced markedly on two machines by retempering the rods in oil after 500 or 600 ft. of drilling. On the third machine, where it has apparently been overcome, the rods in use have been upset to 1½ in. on each end, threaded, and oil tempered, increasing the theoretical strength in the ratio of 1.56 to 1. This type of rod is recommended by Ingersoll-Rand. The rods have drilled more than 1,500 ft. in the three months that they have been in use, and not a single rod has broken or chipped. Moreover, this drill can be operated with the full air pressure, whereas with the other two drills only half or less of the full pressure may be used. Consequently, drilling speed with the third machine is faster than that obtained under identical conditions with the two other drills.

Results achieved in studying rod breakage led to a similar consideration of the shanks. The original shanks consisted of a single piece of 1¼-in. hollow round steel, plugged on the chuck end. These broke frequently, and, owing to their single-piece construction, each shank could be repaired only three times, after which it had to be thrown away. The shanks employed as a result of the investigation are made in three pieces: the shank; the water-swivel collar, which also acts as a coupling; and the adapter. Breaks always occur at the adapter; and, inasmuch as this is a small piece of 1¼-in. hollow round steel, with rod threads on both ends, it is easily replaced. The drill with which the upset rods are employed has an adapter made of 1½-in. cold-rolled shafting. So far, this has not broken.

Second to rod breakage as an item of expense comes stuck rods and bits. Success in extracting rods and bits is usually dependent on the skill of the drill runner and the power of his machine. An attempt has been made recently with no marked success, but with possibilities, to loosen a stuck string of rods with jars. Some progress has been made with the problem of stuck bits. Three kinds of bits are used for different types of ground at the discretion of the driller: (1) a crossbit, with a center hole, for hard ground and ground that breaks coarsely; (2) a crossbit, with a side-bored hole that points forward, in shale or soft ground, and (3) a Carr, or bull bit, in rubble and caving ground. This bit is much easier to extract than the larger crossbits. By using bits adapted to the ground drilled, the number of stuck bits was reduced materially.

Stellite, as a facing on the cutting edge of a bit, was tried experimentally in the fall of 1930. Results showed that a stellited bit would cut from six to eight times as much rock as an ordinary tempered steel bit. This led to the stelliting of all the bits. Stellite must be applied correctly, however, or it will chip and break away from the steel of the bit.

Underground practice with the deep-hole drills differs little from similar operations elsewhere. The "H" set-up is used to insure rigidity. No satisfactory device has yet been developed that will help the drill runner by partly supporting the weight of the rods in a hole. Two experienced men can, however, without any such aid, under limited conditions, drill a hole safely to any reasonable depth. The deepest hole at Gilman, 228 ft. at an inclination of 45 deg., was drilled by two men.

The use of eight changes of bits has been discarded. Stellited bits hold their gage and cutting edges so well that many holes are bottomed with the original bit. Some bits have drilled 125 ft. before losing gage. Three bit sizes are carried in stock: No. 1, 3⅛ in.; No. 2, 3 in.; and No. 3, 2¾ in. Smaller ones are made up on order. Even in holes in quartzite a No. 1 bit can be used for any required distance. In such instances the driller takes six to eight bits, and, using the largest, determined by calipers, drills with it as far as it will go. The second bit is then driven to the back of the hole. Rotation is started by the machine, aided by the drill helper using a large Stillson wrench. Rotation

This is the third of a series of articles on the operations of The Empire Zinc Company at Gilman, Colo.

Rock structure along the Ocean-to-Ocean Highway, near Gilman

starting requires good equipment, as breakage at the bit at this time would cause the hole to be lost. The second bit is used until its gage is worn, at which time it will easily pass through the narrow section of the hole left by the first bit. This process is repeated until softer ground is reached, when a No. 2 bit is used and the hole completed. In shale and similar ground fast drilling has been found advisable. Two drill crews work twelve hour shifts until the objective is reached. If this is not done, the hole usually caves and has to be abandoned.

Sampling of drill cuttings is simple. The cuttings are caught in a powder box, and, after every 6 ft. drilled, a sample is obtained by taking a section of the contents from the top to the bottom of the box. The sample is placed in a can, to which a wooden tag is attached that bears the hole number and a record of the part of the hole represented by the sample. Filled sample cans are placed in a second powder box for delivery to the laboratory. Such procedure is as accurate as conditions require. The ore is of a grade that does not necessitate close sampling and is so friable that the sample is usually contaminated. A composite assay of ore in a drill hole is regarded as sufficiently accurate, however, to be used in ore reserve calculations. Confusion as a result of the salting of waste is avoided by daily reports from the driller that show the type of rock penetrated. From general experience, by the color of ore the return water, and by the speed of drilling he can distinguish between the drilling of sulphide and the drilling of waste.

Surveying of deep drill holes at the property was started only recently. Inasmuch as the projection of the hole in a vertical plane is the only information required, owing to the blanket character of the orebody, no attempt is made to find the lateral deviation of the hole. Equipment used consists of a cylindrical container, with an outside diameter of $2\frac{3}{4}$ in., reduced and threaded on both ends to fit the standard couplings. It has a compartment $1\frac{1}{2}$ in. in diameter and 6 in. deep that is sealed by a screw cap with a left-hand thread. A flint glass medicine bottle, $1\frac{7}{16}$ in. in diameter by $4\frac{1}{2}$ in. deep, is used as an acid container. Concentrated hydrofluoric acid, diluted 3 to 1, is put in the bottles, which are set in wax in the containers to prevent movement. Four containers are used in a string of rods. After the rods have been pushed into a hole, they are left in place until the uppermost bottle has been in the hole two hours. The rods are then drawn out of the hole, and the bottles are removed from the containers, emptied, washed by the driller, and sent to the office. At the office the geologist plots the course of the hole from the information obtained.

Surveying results show that no general rule can be applied to the course of drill holes at the property. Usually, in either hard ground or waste, a hole will droop from the start and lose from 12 to 15 ft. in 150 ft. In soft ground the rods climb for the first 50 ft. and are usually near the desired elevation when they cross the 150-ft. mark. From that point on they droop fast. Office work connected with deep drilling covers the planning and recording of the work done. The geologist plans the work, under the supervision of the mine chief, and has direct charge of the drills. Usually a drilling program is laid out for a certain piece of ground, and one drill is moved into it. The drill crew is given an outline of the work to be done and remains on that job until the work is finished.

From the laboratory the samples are sent to the mine office, where they are screened by the mine sampler and the minus 10-mesh plus 28-mesh product placed on a sample stick. At the same time the geologist inspects the cuttings and makes a written description of each sample. This record is kept in a notebook on printed forms. Assay results, position of hole, and directional data are recorded both on the stick and in the notebook. Survey results are plotted on drawing paper and acid bottles are filed. From the daily report of the

Table I—Time Distribution and Footage for Three Deep-Hole Drills

Month 1930	Time Drilling, Per Cent	Time Moving, Per Cent	Time in Trouble, Per Cent (a)	Feet Drilled Per Shift
June	70.4	7.6	22.0	13.9
July	84.2	7.2	8.6	15.1
Aug	86.7	5.5	7.8	18.1
Sept	74.6	4.2	21.2	14.6
Oct	77.9	7.2	14.9	17.8
Nov	71.5	12.9	15.6	15.9
Dec.	77.6	8.9	13.5	15.5
1931				
Jan.	83.8	5.0	11.2	16.3
Feb.	78.8	9.0	12.2 (b)	12.9
March	75.5	8.8	15.7 (c)	14.2
April	78.2	11.0	10.8	22.7
May	79.6	12.5	7.9	33.1

(a) Includes fishing, stuck rods and bits, machine repairs, repairs to air and water lines.
(b) One drill in quartzite.
(c) New upset rods in use and one drill in quartzite.

Table II—Summary of Deep-Hole Drilling Costs

Year	Footage Drilled	Labor Cost	Labor Cost, per Foot	Cost of Supplies	Cost of Supplies, per Foot	Total Cost	Total Cost, per Foot
1925	2,492	$1,328.28	$0.533	$694.96	$0.279	$2,023.24	$0.812
	(One drill operating on halftime basis.)						
1926	1,840	814.69	0.443	435.98	0.237	1,250.67	0.680
	(One drill operating on halftime basis.)						
1927	3,355	1,406.53	0.419	372.34	0.111	1,778.87	0.530
	(One drill operating on halftime basis.)						
1928	4,425	2,166.06	0.490	853.18	0.193	3,019.24	0.682
	(One drill operating on fulltime basis.)						
1929	4,494	3,204.70	0.713	585.34	0.130	3,790.04	0.843
	(One drill operating on fulltime basis.)						
1930	12,851	9,870.51	0.768	1,692.02	0.132	11,562.53	0.900
	(Three drills operating on fulltime basis.)						
1931 (5 mo.)	7,541	5,710.80	0.757	1,513.49	0.201	7,224.29	0.958
	(Three drills operating on fulltime basis.)						
Totals	36,998	24,501.57	0.662	6,147.31	0.166	30,648.88	0.828

driller, which is also filed, a summary sheet, made up at the end of each month, shows time distribution and drilling rate. The drill runners and helpers are all experienced American machinemen, and the wage scale is made sufficiently high to attract this type of worker. They keep the equipment in good order, practice safety, and stay on the job over long periods of time. With three drills operating, just enough rivalry between crews invariably prevails to give good results.

Time distribution data, as well as footage drilled, for the three drills during the period of a year are presented in Table I. Table II shows costs for more than six years. The recent high cost is attributable to increased drilling trouble encountered toward the close of 1930, to expenditures for experimenting, and to new equipment purchased in 1931. A more detailed cost record for the twelve months ended May, 1931, is presented in Table III.

Table III—Detailed Deep-Hole Drilling Costs for Twelve-Month Period

Month 1930	Footage Drilled	Operating Labor Cost	Operating Labor Cost, per Foot	Maintenance Labor Cost	Maintenance Labor Cost, per Foot	Cost of Supplies	Cost of Supplies, per Foot	Total Cost	Total Cost, per Foot
June	1,044	$745.00	$0.714	$178.35	$0.171	$56.51	$0.054	$979.86	$0.939
July	1,061	604.00	0.569	144.78	0.136	62.41	0.059	811.19	0.765
Aug.	1,391	829.50	0.596	156.08	0.112	69.22	0.050	1,054.80	0.758
Sept.	906	663.50	0.732	213.84	0.236	30.38	0.034	907.72	1.002
	(Trouble with broken rods. New equipment purchased in January and April begins to break down.)								
Oct.	1,015	543.50	0.535	297.52	0.293	251.66	0.248	1,092.68	1.077
	(Experimenting and trying out new equipment.)								
Nov.	1,112	781.50	0.703	317.56	0.286	353.07	0.318	1,452.13	1.306
	(Experimenting with stellite [a].)								
Dec.	1,117	755.38	0.676	218.99	0.196	157.37	0.141	1,131.74	1.013
	(Experimenting with stellite [a].)								
1931									
Jan.	1,387	921.88	0.665	285.75	0.206	190.27	0.137	1,397.90	1.008
	(Experimenting with stellite [a].)								
Feb.	942	778.50	0.826	290.75	0.309	67.26	0.071	1,136.51	1.206
	(One drill operating in quartzite.)								
March	1,108	1,004.50	0.907	343.65	0.310	799.48	0.722	2,147.63	1.938
	(One drill operating in quartzite using new upset rods.)								
April	1,785	932.12	0.522	240.00	0.134	199.05	0.112	1,371.17	0.768
	(Satisfactory equipment and operation.)								
May	2,319	663.94	0.286	249.71	0.108	257.43	0.111	1,171.08	0.505
	(Satisfactory equipment and operation. One drill under repairs for ten days.)								

(a) One pound of stellite makes fourteen bits, at a total cost of $0.285 per bit. A bit can be made in 40 min. and can be used about twelve times before reshaping in a drill sharpener is required.

Operating labor includes all underground labor, such as drilling, timbering, preparing drill stations, pipe work, and clean-up. Maintenance labor covers outside labor, including maintenance of equipment, stelliting, machine repairs, experimenting, and fabrication of new equipment. Supply costs comprise costs of operating supplies, maintenance supplies, new equipment, and supplies for the machine shop that are used directly for deep-drill maintenance. Total costs per foot do not include the following additional undistributable charges: $0.052 for assaying; $0.024, office expense; and $0.093, geologists and engineers.

Diamond drilling has been carried on at Gilman at intervals since 1922. On account of the loose and open character of much of the sulphide ore, many difficulties have been encountered, and the cost has been too high to encourage extensive use of the method for outlining and sampling orebodies.

In one campaign eight holes were drilled, using at various times the following bits: *N* bits, $2\frac{3}{4}$ in. outside diameter; *A* bits $1\frac{31}{32}$ in. outside diameter; and *E* bits, $1\frac{7}{16}$ in. outside diameter. This drilling showed that an *N* bit gave the best results; an *A* bit fair results; and that an *E* bit was useless except in hard rock. The drilling, which was purposely laid out in difficult ground, average 7.4 ft. per shift. This low average was mainly the result of an extensive use of cement. Usually cement had to be employed at the end of each shift, and often at the end of each run. Without cement, however, drilling would have been impossible in soft ore. In hard ore drilling was possible without cementing, except when in vuggy ground.

Cement will set sufficiently hard overnight to permit drilling the next day. In vugs in hard ore it goes beyond the hole, adheres well to the ore, and, because of the relative softness of the cement, the hole is seldom deflected. In soft ore the reverse is true, the cement does not entirely mix with the sand grains, and the wall rock is usually softer than the cement. This causes serious deflection with an *E* bit. An *A* bit was found to avoid part of this trouble, owing to the greater rigidity of the *A* rods.

Core recovery in hard ore averaged 50 per cent, and in some ore was as high as 75 per cent. In the soft ore recoveries ranged from 0 to 40 per cent. Sludge recoveries in hard ore were fair, except when the drill encountered open ground, when all the sludge was lost. In soft ore recoveries were usually good, because the water could not escape through the porous rock fast enough to prevent sludge recovery at the collar of the hole. If the hole were cemented every shift in this type of ore, sludge recoveries were usually reliable. Carbon loss was found to be three times greater in soft ore than in hard ore. This paradox is apparently explained by the supposition that the soft ore packs around the bit and abrades all exposed faces of the carbons, whereas in hard ore the wear is on one surface only.

Time distribution records showed that of the 124 shifts worked under the contract, drilling consumed 43 per cent of the time; cementing, 27 per cent; reaming and casing, 4 per cent; fishing and repairing, 4 per cent; moving, 8 per cent; and miscellaneous items, 14 per cent. Costs, exclusive of drill rental, were $7.126 per foot, distributed as follows: direct drilling labor, $1.884; maintenance labor, $0.205; supplies, $0.500; carbon, $1.265; stations, $0.921; general charges, $2.351. This contract showed that diamond drilling is expensive and not very satisfactory for exploration of orebodies of the type found at Gilman.

Diamond drilling in the country rock is a much simpler matter, and one machine is employed in drilling for structure in limestone, quartzite, and shale. The drill used is a Sullivan Turbinair, with a rated capacity of 800 ft. of 15/16-in. core. An *E-S* bit, 1 17/32 in. outside diameter and 15/16 in. inside diameter, is used. In the limestone and quartzite results are good, 77.9 per cent of the core being recovered for 3,429 ft. drilled. The Cambrian shale has proved difficult to drill, owing to its unconsolidated, water-soaked nature that makes it almost impossible to keep open, even with cement. Barring this one troublesome horizon, however, the diamond drill is effective for structural drilling at Gilman. Costs are not available because the drilling is contracted on a footage basis.

Rugged topography and the town of Gilman, as seen from Battle Mountain

Materials Handling by Telpher at Port Pirie Lead Smelter

UNOSTENTATIOUSLY prosecutting a spirited program of research in all phases, the Port Pirie lead smelter has, during recent years, made remarkable technical progress. With the perfecting of processes, now in the experimental-plant stage, for continuous softening and continuous desilverization of bullion, a development of far-reaching effect in lead metallurgy is promised. Concurrently, the company has eagerly adopted the latest developments in engineering. Among these, the most important is the installation of a complete telpher system for the transport and handling of the large tonnages of fuel, fluxes, furnace feed, and drosses. As was expected, the system has reduced working costs, eliminated congestion and rehandling, and, by lessening dusting and improving ventilation, has markedly reduced the incidence of lead poisoning among plant operatives. The huge expenditure called for in the installation has therefore been amply justified.

The telpher transport handling scheme was designed by Messrs. Fyvie and Stewart, consulting engineers in Melbourne, in close cooperation with the engineering and metallurgical staffs of the Broken Hill Associated Smelters, which owns and operates the Port Pirie plant. Preparatory constructional work was commenced late in 1926, and the installation was completed and placed in operation in January, 1929.

The installation consists of three sections: the first running lengthwise along the wharf, the second commanding the main storage bins, and the third spanning the seven blast furnaces and supplying the feed therefor. No. 1 section is 395 ft. long and runs parallel to the wharf front, where the depth of water is sufficient to accommodate large overseas vessels. The modern bulk-handling equipment, erected along the wharf, consists of three Babcock & Wilcox luffing jib cranes of 7½ tons' capacity, together with accessory equipment. The telpher runway is located at such distance that the jib of the wharf cranes at maximum extension will safely clear.

Along the wharf, storage space is provided, under the runway, for 10,000 tons of blast-furnace coke and 3,000 tons of lime-sand. A mechanical coke-screening plant is centrally installed at the coke storage, so the proportion of fines in the coke fed to the blast furnace is greatly reduced. The lime-sand is a wind-blown limestone containing 86 per cent calcium carbonate and 6 per cent magnesium carbonate, and is used as a flux component of the Dwight-Lloyd blast-roasting charge. The sand is obtained from Wardang Island, Spencers Gulf, South Australia.

No. 1 section is depicted in Fig. 1. On the extreme left is seen the wharf with the storages of coke and white lime-sand, and in the central background are the three jib cranes. On the right, No. 2 section is seen junctioning with No. 1.

No. 2 section, 456 ft. long, is at right angles to the wharf section and connects this latter to No. 3 section, located over the lead blast furnaces. This connecting section spans the main storage bins and commands the operating yard or assembling area in front of the final D. & L. sintering machines.

The storage bins are of the following over-all dimensions: length, 140 ft.; width, 29 ft.; height, 33 ft.; and are sectionalized to afford storages to the following materials:

	Tons
Screen coke	225
Returned slag	725
Ironstone	390
Copper dross	390
Lead dross	390
D. & L. sinter	1,225

Returned slag is quarried from a large dump, formed in the early days of lead smelting at Port Pirie, and is added to the blast-furnace charge to reduce the zinc content of the slag produced to 18 per cent metallic zinc. This is considered the most economical zinc concentration. The slag is delivered from the quarry in 5-ton Leyland motor trucks and is dumped into a small bin located below ground level. This bin is discharged by a conveyor belt which is set in motion by the lowering of a telpher skip and stopped by an electric cutout that comes into operation when the requisite weight of slag has been delivered into the skip by the conveyor.

Copper dross is obtained in the cooling of blast-furnace bullion when the copper, present mainly as copper sulphide, is removed as a crust or dross. Lead dross results in the refining for market of the desilverized lead. Both

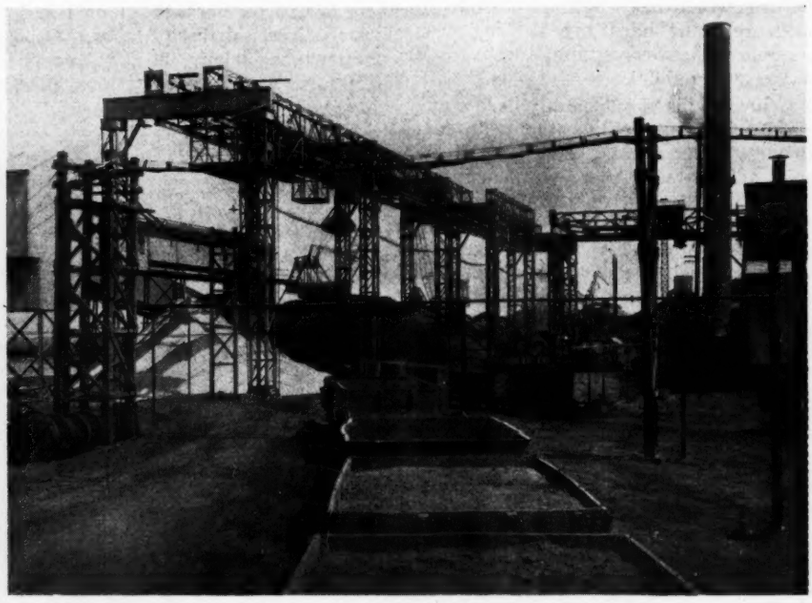


Fig. 1—No. 1 section of the telpher system

Contributed by a competent and qualified Australian mining engineer who, because of professional connections, is obliged to remain anonymous.

drosses are loaded into telpher skips at their respective points of origin, and the skips, supported on skeleton rail-trucks, are hauled to the operating yard to be elevated and dumped into the storage bin. When sufficient of these drosses has accumulated, they are smelted together in a small (No. 7) blast furnace to give a marketable lead-copper matte. The D. & L. sinter in the storage bins is used when the production in the D. & L. plant is not sufficient for blast-furnace requirements.

The storage bins may be discharged on either side into measuring hoppers mounted on weighbridges. These hoppers feed into the skips of a secondary telpher installation by means of which the components of the blast-furnace charge are assembled in a standard telpher skip placed below on the operating yard level. The secondary telpher skips are of 2-ton capacity and are filled with traveling gear only.

Fig. 2 is illustrative of No. 2 section of the telpher installation and of the secondary telpher. The main runway is shown spanning the storage bins. The stack at the discharge end of a final D. & L. machine is on the extreme left and the operating yard is in the foreground. A storage-battery truck is shown hauling a standard telpher skip from the D. & L. plant to the secondary telpher, on which may be seen a small skip delivering a blast-furnace component into a standard telpher skip. The illustration on the front cover gives a close-up above the main storage bins and shows a coke grab and a standard telpher, bottom-discharge skip above the bins.

The blast-furnace section, No. 3, is 306 ft. long and spans the six lead blast furnaces and the small lead-copper dross furnace. Each furnace is provided with a steel super-hopper or small bin, into which the telpher skip drops the blast-furnace charge. The super-hopper is of 25 tons' capacity and is fitted on each side with four discharge gates independently operated by gearing.

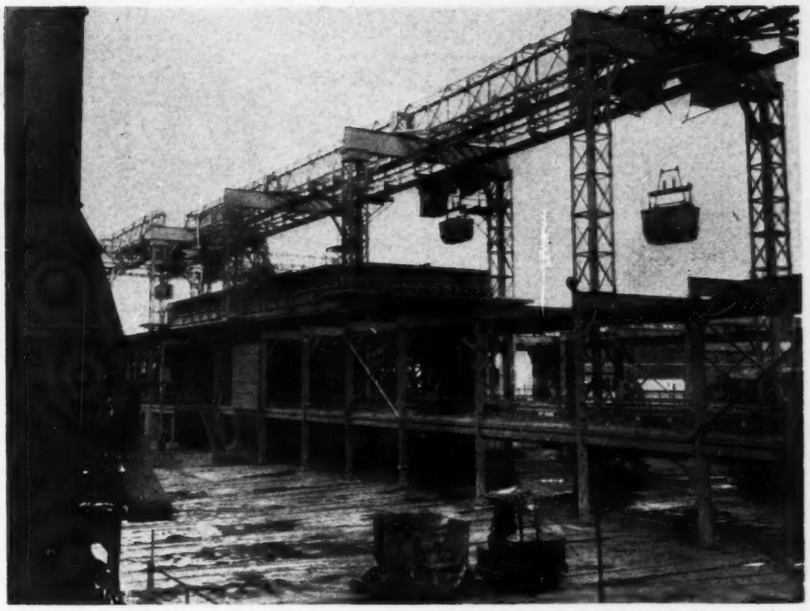


Fig. 2—No. 2 section, and the secondary telpher

No. 3 section is shown in Fig. 3 running along above the blast-furnace feed floor seen on the right. At the upper left, No. 2 section is shown. A general view of the complete telpher installation is presented in Fig. 4. On the right is No. 1 section, parallel to the wharf front; in the middle distance, No. 2 section, with storage bins and secondary telpher; and on the left is No. 3 section, above the line of blast furnaces. The total length of the overhead telpher runways is 1,150 ft., and the installation covers an area of more than two acres.

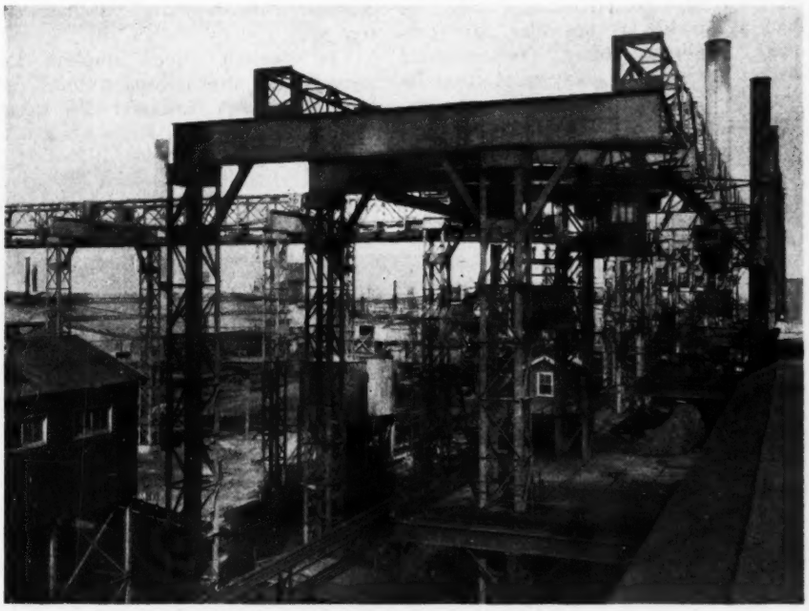


Fig. 3—No. 3 section, above the blast-furnace feed floor

Having considered the general layout, the main engineering features may properly be outlined before presenting a description in detail of the preparation of a charge for the blast furnace under this new system. The main telpher structure is of steel, 58 ft. high to the monorail level on which the telpher units run, and 67 ft. high over all. Twenty-four pairs of latticed steel columns support the overhead runways, the spacing being 70 ft. except along No. 3 section, where the grouping of the blast furnaces made necessary a spacing of 45 ft. To the column caps are riveted the connecting plate girders that support horizontal lattice girders, above which are set down the monorails of 18x7-in. rolled-steel joists.

The steelwork was designed to support a live load of two telpher units on one rail and one unit, traveling in the opposite direction, on the other rail. Under this condition of loading the total live load is 35¼ tons.

The telpher units or trolleys were designed for a 5-ton lift (total weight of skip and load 11¾ tons) with a hoisting speed of 60 ft. per minute and a traveling speed of 400 ft. per minute. The units have an over-all length of 21 ft. 5½ in., with an 8-ft. 6-in. wheelbase. The hoisting motor is 27½ hp., and the traveling motor, 11½ hp.; both run at 725 r.p.m., and operate on a 3-phase, 550-volt, 50-cycle circuit. Three T-section collector bars of Swedish iron are provided, supported by insulators spaced at 10-ft. 6-in. centers.

Cross-over switch lines are arranged to allow the transfer of a trolley from one line to the other, thus obviating the necessity of traveling around the terminal curves of the section. The complete installation has seven telpher units supplied by Messrs. Herbert Morris,

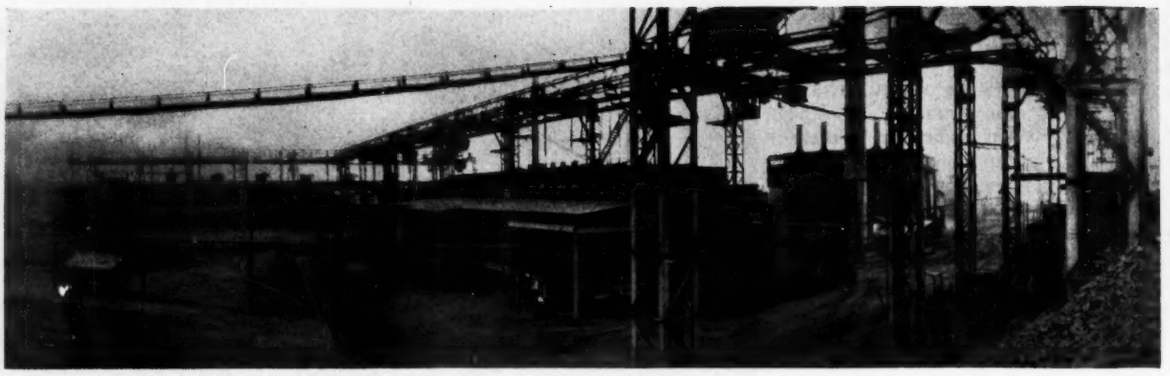


Fig. 4—General view of the complete telpher installation

Ltd., of Loughborough, England. With the blast furnaces treating 1,750 tons of total charge per 24 hours, the allocation of the units is as follows:

Three units per shift delivering the charge to the blast furnaces.

One unit per shift carrying screened coke from the wharf to the storage bin.

One unit day shift for six days per week hauling slag to the storage.

Two units in reserve.

The method of operation of the telpher installation may best be described by detailing the preparation of a blast-furnace charge. At the discharge end of each of the six D. & L. final roasting machines is a small storage hopper into which the pallets of sinter fall. Below the hopper is placed a standard telpher skip, and when the skip has received the contents of ten pallets of sinter the control on the main sprocket wheel of the D. & L. machine energizes a solenoid that trips the door of the hopper, thus closing it. The pallets of sinter are then stored in the hopper until another telpher skip is placed in position. Because of the regularity of feed constituents and the accurate leveling of the charge as fed, each pallet contains a fixed weight of sinter, so that the weighing of the sinter in the telpher skip is not necessary.

The feed to the first or pre-roast section of the D. & L. plant, which comprises seven machines with a capacity of 8½ tons per hour each, is made up of the following constituents:

	Per Cent
Broken Hill granular lead concentrate	43
Broken Hill slime flotation concentrate	22
Siliceous ore	4
Lime-sand	4
Risdon residue	14
Granulated slag	13

The sinter from the initial roast contains 6.5 per cent sulphur, but after crushing and re-roasting in six machines, this figure is reduced to 2.2 per cent, the final sinter as discharged into the telpher skips assaying:

Lead, per cent	46.9
Silver, ounces	21.9
Zinc, per cent	10.6
Sulphur, per cent	2.2

The telpher skip, with the ten pallets of sinter, is hauled by a storage-battery truck, of which there is one in the operating yard each shift, to a spotting point under the line of the secondary telpher, and to the sinter is then added the other components of the blast-furnace charge. These normally consist of:

	Pounds
Sinter	6,000
Returned slag	1,100
Ironstone	150
Coke	600-720

Should the supply of sinter be in excess of furnace requirements, the material is carried by the main telpher system to the sinter storage bins. The telpher skip with its completed charge is hauled under the main telpher, elevated, and transported to the super-hopper of a furnace.

The Port Pirie telpher installation can properly be considered as thoroughly tested, for it has been in continuous service over two years. The scheme was thoughtfully considered, in all its aspects, for many years before being adopted, as it was expensive; but having once been decided upon, it was prosecuted in haste and diligence so that the obvious advantages might be had as quickly as possible. Its complete fulfillment of all requirements makes justified the great satisfaction the smelter's staff, the consulting engineers, and the suppliers of the equipment feel in this massive monument to their endeavors. One knows, in all details, what is required; the second lays out the scheme whereby these requirements may be attained; and the third fashions and fulfills the requirements. This trinity, at work more and more in plants of all descriptions, in all places, is one of the greatest modern aids to metallurgical progress.

Acknowledgment is made to Messrs. Fyvie & Stewart, of Melbourne, for the details of the telpher handling system and for the fine photographs reproduced herein.

The Port Pirie lead smelter, originally established by the British Broken Hill Proprietary, and acquired thirty years ago by the Broken Hill Proprietary, has been controlled since 1925 by the three important Broken Hill companies—Zinc Corporation, Broken Hill South, and North Broken Hill. The smelter is operated as a separate company called Broken Hill Associated Smelters, which, by agreement, purchases the whole of the lead concentrate output of the three Broken Hill mines mentioned. In addition, the smelter treats the residue of the Electrolytic Zinc Company's plant at Risdon, Tasmania, and purchases custom ore.

The smelter, which employs 1,600 men, has an annual capacity of 175,000 tons of market lead and 270 tons of market silver.

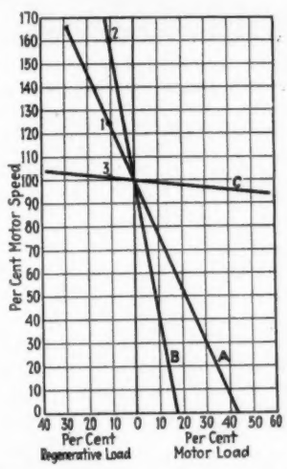
■ ■

Transporting concentrate to railhead in Malaya

Improving the Operation of a Slope Hoist

A SLOPE HOIST that gave unsatisfactory service in several ways was investigated by R. F. Emerson, of the Industrial Engineering Department of the General Electric Company, who writes as follows:

When a full car was accelerated from rest on a level track at the foot of the incline, too sudden a tightening of the haulage cable occurred. When started down the incline, an empty car was supposed to overhaul the motor; but the motor would start up too quickly and unreel loose cable faster



Speed-torque curves of 50-hp. wound-rotor motor operating slope hoist. *C*, Speed-torque curve with slip rings short-circuited. *A*, Speed-torque curve originally obtained on first point of controller. *B*, Speed-torque curve obtained on first point of controller with new resistor.

than the car could take it up. Another trouble was the "whipping" of cable when a loaded car was retarded to rest at the foot of the incline. To lower an empty car at about 160 per cent of the hoisting speed was also desired, so as to make the required number of round trips per hour. With the control in use, only about 124 per cent of synchronous-motor speed was obtainable.

The cycle of operation consisted of hoisting a car of ore having a total weight of 12,000 lb. up a slope 350 ft. long, the grade of which varied from nil at the foot to 25 or 30 per cent. After dumping 8,000 lb. of ore at the top of the grade, the empty car had to return at 640 ft. per minute, or about 60 per cent faster than the full car was hoisted. A 50-hp. wound-rotor induction motor, with semi-magnetic control, was used.

A speed torque curve of the motor as originally operated with all secondary resistance in circuit is indicated in the cut, at Curve *A*. When lowering an empty car with the controller on the first point, the car was so light that the load was only about 10 per cent regenerative, so that the speed was about 124 per cent of synchronous speed, as indicated by point 1 on Curve *A*.

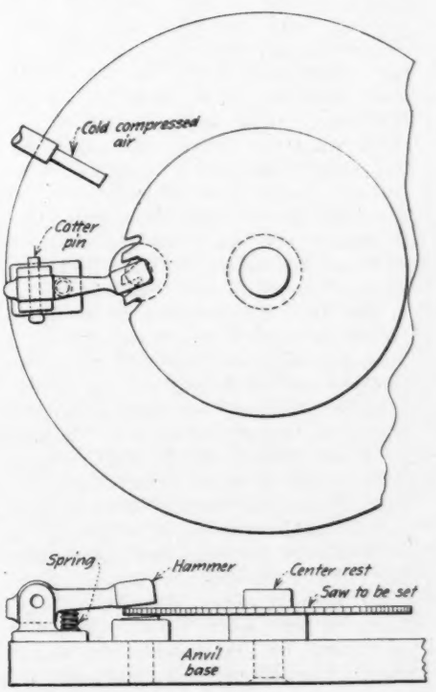
To get 160 per cent speed at 10 per cent regenerative load, point 2 was located, and a new Curve *B* was drawn through point 2. This new point indicated that the motor would exert 17 per cent of full-load torque at zero speed. Inasmuch as Curve *A* required 1.04 ohms in the secondary resistor, Curve *B* would require $1.04 \times \frac{43}{17} =$ 2.64 ohms per phase. Resistance was increased to this value, and the desired increase in speed was obtained. The reduction in starting torque reduced the rate of acceleration in starting, so that no undue jerk was imparted to the cable. The motor also accelerated more slowly when starting an empty car down grade, and did not unreel more cable than the car could take care of. When the car approached the bottom of the incline, the controller was notched around from the first point in the lowering direction to the full-on lowering position, with all resistance cut out, and the speed was reduced from 160 to 101 per cent (point 2 on Curve *B* to point 3 on Curve *C*). The next operation was to reverse the controller to the first point in the hoisting direction, which reversed the power and reduced the speed to less than half speed, after which the controller could be brought to the off position, and the solenoid brake would set without undue whipping of the haulage cable.

Care had to be observed when a full car was lowered, because the greater weight would dangerously overspeed the hoist if a loaded car was lowered on Curve *B*. During the normal course of operation of the hoist, however, only an empty car was lowered.

■ ■

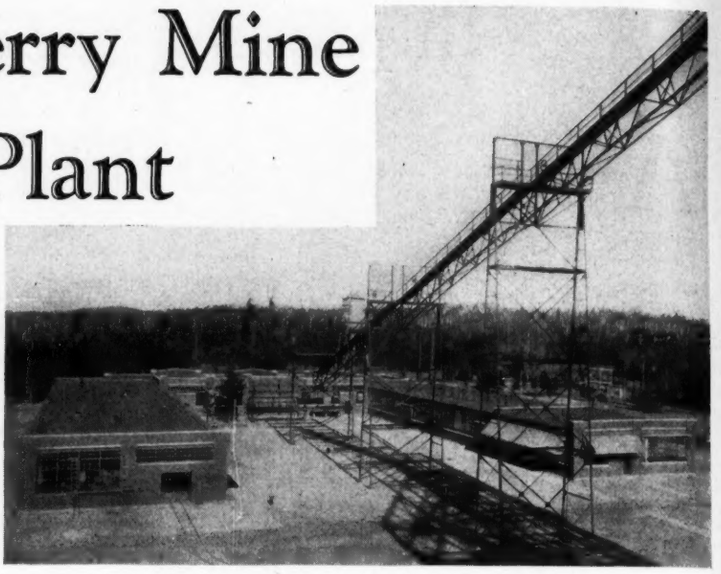
Ingenious Saw-Setting Jig

CORRECT setting of saw teeth is an important factor in maintaining the life and efficiency of a circular power saw. Unevenly set teeth, so common when the work is done by hand, produce ragged cuts, with loss in cutting speed. This can be avoided by setting the teeth mechanically with the device developed by Charles R. Clarkson, master mechanic at American Smelting & Refining's smelter, at Hayden, Ariz. The jig illustrated in the accompanying sketch consists of a cast-iron base; a center rest; a steel anvil with the correct setting angle; and a spring-controlled hammer, with a mild-steel support attached to the base. Each tooth of the saw revolving on the center rest is heated with an acetylene torch with neutral flame, placed over the carefully aligned anvil, and hammered down with a few mild taps on the hammer head. Finally, the teeth are retempered by a stream of cold compressed air.



Ford's Blueberry Mine Has Unique Plant

A. H. Hubbell
Associate Editor



Mine shops, engine room and offices, Blueberry mine. Compare with Fig. 2.

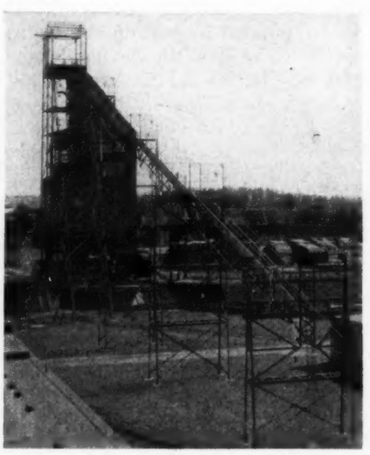
ONE of the most interesting mine surface plants to be found in the United States is that of the Ford Motor Company's Blueberry mine, which is on the Marquette range in northern Michigan. Despite the attention it has received locally, little regarding it has appeared in print, so the following description may find readers to welcome it. A short sketch of the underground operations is added. The data presented were obtained on a recent visit to the property, which was made possible through the courtesy of the Ford Motor Company.

The Blueberry mine is situated about seven miles west of Ishpeming, the nearest community of any size, the property being leased from the Palms-Book Land Company. Its nearest neighbors are the American mine, two miles to the west, and the Morris-Lloyd mine of the Cleveland-Cliffs Iron Company, two miles to the east. The topography of the region is that typical of the Marquette range, low hills showing frequent outcrops and interspersed with level or gently rolling arable stretches, well wooded with second-growth timber, evergreens and white birch predominating. The plant site is on one of the level stretches, some acres in extent. Blueberry's shaft collar is 1,587 ft. above sea level. Three railroads serve the mine: Chicago & Northwestern; Duluth, South Shore & Atlantic; and the Lake Superior & Ishpeming. Ore shipments are made to the railroad docks at Marquette, on Lake Superior, about 25 miles to the east, and thence to the River Rouge plant of the Ford Motor Company by the latter's boats.

Geologically, the property is on the northern limb of the ore-bearing formations in which the ore deposits of the Marquette range occur. It extends about two miles along the strike, which at this point is approximately east and west. In age, the ore has been assigned to the Middle Huronian, occurring in the bottom of the Negaunee iron formation, the concentration taking place along intrusive dikes. The deposit dips about 84 deg. north, unlike practically all others on the range, which dip south. The footwall is a jasper and the hanging wall a diabase dike. One orebody has been found, which is of varying width. The ore is a soft hematite, the existence of hard ore being as yet undetermined.

The Blueberry is a virgin property, having been opened from the grass roots by the present company. Clearing of the ground was begun in August, 1926. The shaft, which is now down 1,100 ft., was collared that November. In 1929 the first production was recorded, amounting in round figures to 52,700 tons. The following year, 1930, the tonnage rose to 189,100, and in 1931 it is expected to reach a larger figure. The ore is non-bessemer, the grade guaranteed for 1931 being representd by the following analysis (dry): Iron, 55.0 per cent; phosphorus, 0.110; silica, 8.25; manganese, 1.25; moisture, 10.0 per cent. The ore is crushed to 2½- to 3-in. size before delivery to the railroad. In calculating reserves, the tonnage factor used is 12 cu.ft. per ton in place.

At present 178 men are employed, 122 of them underground, every man on full time. There is and has been no curtailment of hours of work. The five-day week, standard at all Ford plants for the last three years, is in effect. Two eight-hour shifts are worked underground, and one eight-hour shift is worked on surface. The regular Ford wage scale is likewise in vogue.



Shafthouse, 124 ft. 8 in. high, and idler stands at Blueberry mine.

The heart of a mine is underground, but the surface plant, like all surficial things, is the part most easily seen. Viewed by light of day, instead of artificial light of limited range, any disorder and ugliness appear always at their worst. That these things are unknown at the Blueberry surface plant is a statement barren of exaggeration. Viewed from any angle, the plant, or any part of it, is attractive to the eye.

The quality of the plant does not lie in its looks alone. These indeed are secondary. In the simplicity, compactness, and efficiency of the surface layout, involving among other things the grouping of all the buildings, save the shafthouse, under a single roof; in the permanent character of the construction; in the consideration given to the comfort of the men; in the bold scrapping of all tradition as to what a mining surface plant should be—in its combination of all these things, the Blueberry plant, it is safe to say, has no equal. Inasmuch as it is the most spectacular feature of this mining enterprise, as well as the thing that a visitor first sees, it will be given first consideration.

Reference to the sketch of the surface layout in Fig. 1, to the floor plan in Fig. 2, as well as to the photographic reproductions, will show that the plant building stands on three sides of a hollow square, with the shafthouse opposite the open side of the square, which is bisected by the hoisting ropes running to the engine room. On the green expanse

which fills the square are the five idler stands. A unique feature of these stands is the broad steel foot walk which links them together (the lowest excepted), running at an easy angle to the tallest, and thence horizontally to the shafthouse, this permitting the oiler to lubricate the idler sheaves with safety and ease. Ordinarily, each idler stand has its separate ladder which must be climbed in the open, no matter what the height or weather be.

The building is a flat-roof structure, 16 ft. high, and of brick, steel, and glass construction, with a concrete floor in all parts except the office and the engine room and a roof of timber and tar paper. In the left wing are housed the blacksmith, the carpenter and machine shops, and supply room and garage, the only partitions being the wall of the garage and the wire screen that incloses the supply room. The central section is occupied by the engine room, which houses the compressors and the hoists. In the northeast corner of the building is the boiler room, the floor of which is 12 ft. below grade. The right wing includes the change room for miners and bosses, a first-aid room, an engineering and clerical room, a room intended for use as a laboratory, and the superintendent's office. From the latter point practically all parts of the plant are visible. Through the end of the opposite wing, housing the shops, runs a track leading from the cage landing at the shaft collar. This traverses the entire length of the shops and warehouse, thus facilitating the transport of steel and other mine equipment between shaft and shops.

Light is ample in all parts of the building. Windows of double-strength window glass reach from a point about 4 ft. above the floor to the high ceiling, and stretch in an unbroken line, save for an occasional doorway, all around the plant on all walls. Awnings serve to shield the southern ends of the wings when the sunlight becomes intense. The interior lighting system in engine room and shops consists of 200-watt bulbs with reflectors, hung from the ceiling on swivel-jointed lengths of pipe conduit, at frequent intervals. These are on a 115-volt a.c. circuit. The office rooms are lighted by 200-watt lamps, the change rooms by 150-watt lamps, and the first-aid room by 200-watt lamps, reflectors being used in every case. The lower five feet of the engine and boiler rooms are painted buff topped by a 1-in. black band. Upper parts of the walls, ceilings, roof trusses, boilers, and piping are painted deep cream color. The boiler room floor is gray, the stairs are black, and the railings olive green. In the rest of the building, excepting the miners' change room and hallway, the floors and the lower five feet of walls and doors are painted gray, and upper walls and ceilings white. In the miners' change room, the floors, the lower five feet of wall, and doors are painted "freight-car" brown, and the upper walls and ceilings are white.

Heat is provided by wall-type radiators beneath the windows. These are painted aluminum except in the miners' change room, where their color is the same as that of the wall.

Space is as ample as the light. The engineering and clerical room, approximately 30 ft. square, is equipped with a large desk, three tables, a book case, a file, and a typewriter desk. The miners' change room contains five rows of 27 full-length lockers for street clothes, the work clothes being suspended by chains from small pulleys attached to a light 1x4-in. strip overhead. This room is kept faultlessly clean, the painted concrete floor being washed down after being used by the men. Here the radiators are placed on top of the lockers so as to dry thoroughly the clothes which hang from the chains. Here the men eat their lunch, being hoisted from underground for the purpose. Special racks are provided for lunch boxes in the center of the floor.

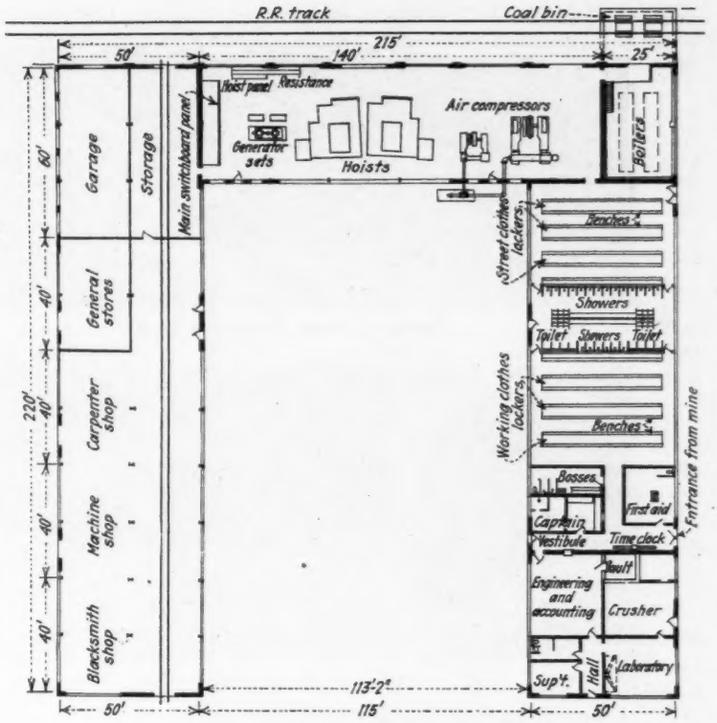


Fig. 2—Floor plan of building housing offices, engine room, change room, and shops at Blueberry mine

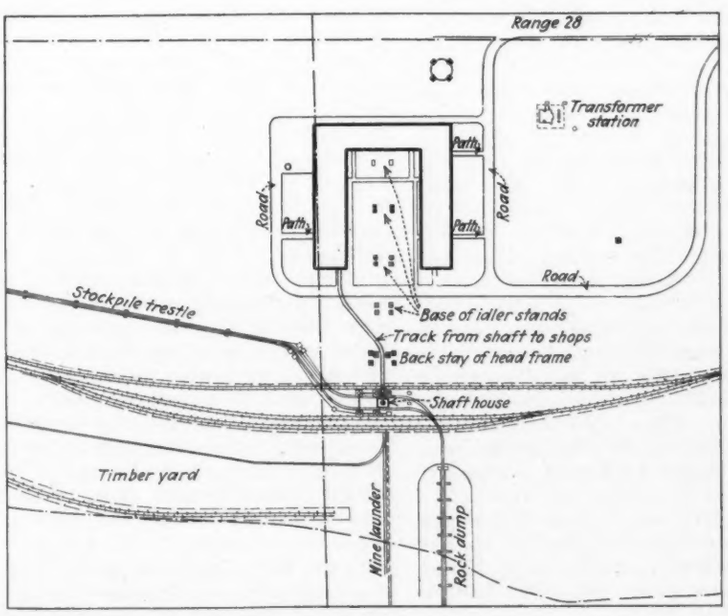
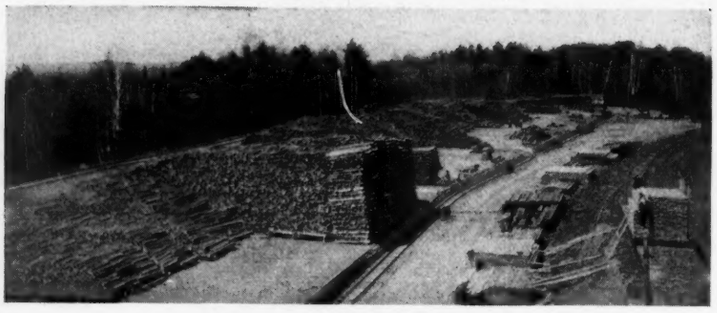
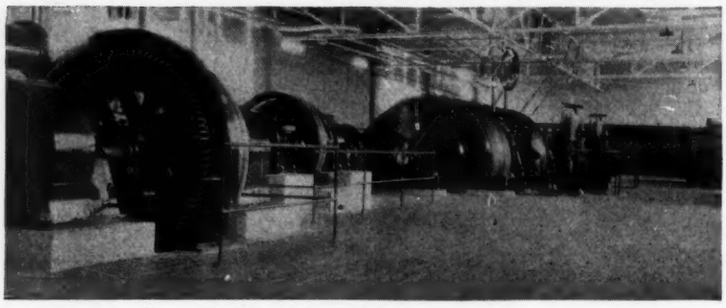


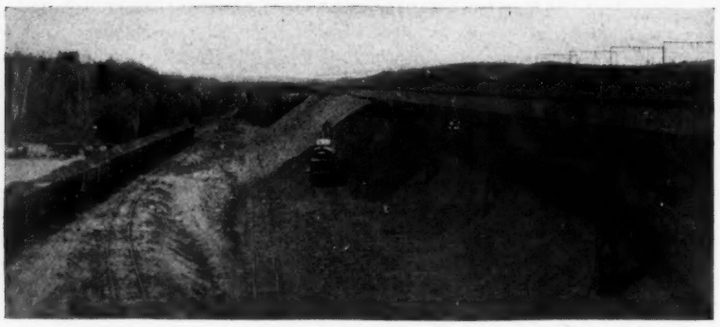
Fig. 1—Layout of Blueberry surface plant



Timber yard at Blueberry mine



Engine room, Blueberry mine



Blueberry stockpile with single-post stocking trestle and electric loading shovel

The air in this room is always kept clean and fresh by ten air-motor ventilators placed in the roof above the lockers.

Adjoining the change room are the shower baths and toilets, the layout marked by similar generosity in allowing space. Equipment is modern and of the best. Beyond these is another change room similar to the first, and used by shop men. In addition, a separate small change room is provided for the executive staff. Carbide, mops, and brooms are kept in a small room adjoining.

In the corridor between the offices and change rooms is the time clock, punched by every employee, a card system being used.

As yet, the space allotted for laboratory purposes is unused, the laboratory of the company's Imperial mine, further west, at Michigamme, serving both properties for the present.

The first-aid room is equipped with two metal chairs; a steel cot; a single bed; a screen; a porcelain sink, a porcelain foot bath, and a wash bowl—all with running water; two steel dressing tables, an operating table, a supply cabinet, an electric sterilizer, lockers, and a toilet. A physician is retained.

The engine room, 140x40 ft., is interesting. A tiled floor of dull red, machinery of a brighter red, cream walls, roof and piping all spotless in appearance, make an attractive combination. The concrete foundation of each machine and the base of the switch board have a terrazzo finish. All railings are painted olive green and the manhole plates black. The building houses two compressors, having a total capacity of 3,258 cu.ft. of air; cage hoist, a skip hoist, and the needful accessory electrical equipment and switchboard. The equipment details are as follows:

One 2,200 cu.ft. horizontal duplex compressor (26—15x18 in., Simplate valves), driven by a 350-hp. synchronous motor (440 volts, 3 phase, 60 cycles).

One 1,058 cu.ft. horizontal duplex compressor (18—11x14 in., having feather valves), driven by a 215-hp. synchronous motor (440 volts, 3 phase, 60 cycles).

One cage hoist, single drum, 10x10 ft., capacity approximately 1,600 ft. of $1\frac{1}{4}$-in. wire rope ($1\frac{1}{4}$-in. rope on cage and $1\frac{1}{8}$-in. rope on counterbalance), spiral groove. Usual safety devices. Driven through a herringbone gear by a 400-hp. induction motor (440 volts, 3 phase, 60 cycles).) Bell and light signals.

One skip hoist, single drum, 10x10 ft., counterbalanced skips, capacity, 1,600 ft. of $1\frac{1}{8}$-in. wire rope. Driven by a 400-hp. induction motor (440 volts, 3 phase, 60 cycles, 349 r.p.m.). Buzzer signal.

One motor-generator set for underground lighting, scraping, and haulage circuits. Induction motor, 440 volts, 3 phase, 60 cycles, 870 r.p.m., full load, d.c. generator, compound wound, 250 volts, no load; speed 870 r.p.m. full load.

One motor-generator set for exciting the 2,200-cu.ft. air compressor. Induction motor, 440 volts, 3 phase, 60 cycles, 1,755 r.p.m. full load. D.C. generator, compound-wound; volts, 250/250; 1,800 r.p.m.

One motor-generator set for exciting the 1,058-cu.ft. compressor. Induction motor, 440 volts, 3 phase, 60 cycles, 1,200 r.p.m., full speed. D.C. generator, shunt wound, 125 volts, 1,200 r.p.m.

Power cables are brought into the power house from the transformer substation through fiber ducts laid in concrete to a tunnel which runs back of the switchboard. From here the cables going down the shaft are also laid in fiber ducts in concrete. Access to the tunnel is gained through two manholes. Four other manholes give access to the cables between the power house and the shaft.

Air pressure is about 100 lb. at the compressor and about 80 lb. at the face. The large compressor is equipped with an aftercooler, which removes water and oil from the air, obviating danger of freezing. The smaller compressor is used between shifts and on Saturdays, Sundays, and holidays. Water is pumped from the bottom of the shaft at the 1,100-ft. level by air to the 800-ft. working level.

Adjoining the engine room on the right is a small boiler plant for furnishing steam for heating the building and the shafthouse. It is equipped with two locomotive-type boilers making steam at 95 lb., which is reduced to 15 lb. for use. Walls, ceiling, boiler covering, and piping are painted buff, railings green, and all valves and the two stacks with aluminum paint. This comparatively small room is lighted with eight 200-watt incandescent lamps with 18-in. reflectors, except the two lighting up the gage dials, which have reflectors of a different type. These are hung on pipe conduits, swivel-jointed at the ceiling. Across the track and about 50 ft. north of the boiler room is a 40,000-gal. steel water tank, painted aluminum, with olive-green standpipe and structural work.

In the left wing, housing the shops, the blacksmith shop is nearest the door, receiving steel to be sharpened and other work to be done via the track that

comes from the shaft and runs the length of the building. It is equipped as follows:

One drill sharpener, using ordinary dies
One oil-fired forge
Two blacksmith coke forges
One punch and shears
One 20-in. shop grinder
One 48-in. grindstone (6-in. face)
One steel tempering tank

As stated previously, the shops have a concrete floor throughout. Next in line is the machine shop. This houses the following:

One 27-in. lathe, 12-in. bed
One power hacksaw
One radial drill press
One 12-in. lathe
One pipe and bolt threader
One pipe threader (2 to 14-in. pipe)
One 12-in. shop grinder, 2-in. face
Four cast iron work benches
One overhead crane for pipe-threading machine

The carpenter shop, which follows next, has the following:

One ripsaw
One 36-in. band saw (25-hp. motor)
One planer, 25 hp.
Metal shelving for tool boxes

Each machine has an individual motor drive with a push-button starter. Shop motors are all a.c. 115 volts, ranging up to 25 hp. in size. All wiring is in conduits, and switches are placed on a platform 9 ft. above the floor, to which only the electrician has access. Oxy-acetylene welding is used throughout the plant and underground.

Beyond the carpenter shop and inclosed in a wire screen, the track running through a gate, is the warehouse. Here stock is kept on a basis of 30 days' supply, a running inventory being kept in a ledger and not on the bins. Stock is checked monthly. At the end of the warehouse, next to the garage, is stocked the heavy material, such as spare pumps, large valves, steel, pipe, cables, and the like. To the north of the shop wing, outside, a spur of the railroad parallels the building, so that heavy freight and coal can be delivered directly to the warehouse or to the coal bin north of the boiler room.

Other interesting features of the surface plant are the timber yard and the ore stockpile. Both lie on the same side of the shaft and parallel with each other. Between the two are the pocket loading tracks. Railroad tracks on both sides of the stockpile serve for loading from it. Another high line track permits delivery of all timber to the upper level of the timber yard. See Fig. 1.

The timber yard occupies a rectangular area approximately 600 ft. long by 125 ft. wide. The plat on which the timber is stored is 12 ft. below the railroad's delivery track. Three feet below the plat and at a distance of about 75 ft. is the track via which the timber is transported to the shaft. The 3-ft. face is cribbed to keep it trim and facilitate handling of the timber. Mine timber from 5 to 14 in. round end and 16 to 18 ft. long is stocked; also 3½- to 4½-in. lagging, 8 ft. long; and 3½ in. tamarack poles, 11 ft. long, which are used for forepoling in the breast or wherever safety requires such support. Lagging is mostly cedar. All timber is framed in the timber yard between storage pile and shaft track.

Blueberry's stockpile trestle is of the single-leg type and of steel. It is 42 ft. 6 in. high, from the top of the foundations to the base of the rail. It consists of ten spans, each 80 ft. long, center to center of the leg, giving 800 ft. of stocking space, which is sufficient for 110,000 tons. Track grade is 3.09 in. per 100 ft. Ore is delivered to stock by a 90-cu.ft. larry car which operates under remote control, current being supplied at 250 volts d.c. from two overhead wires. Additional stocking space can of course be secured by building another trestle parallel to the one in place. Ample space is available.

The trestle is a built-up box girder 4 ft. wide and 5 ft. 2 in. high. The girder is carried on 12-in. channels riveted to the vertical members of the bents. Its bents are of the single-leg type, save the expansion bent in the center of the trestle and the anchor bent at the end. The single bent is built up of two laced 16-in. I-beams, 5 ft. by 2 ft. 3 in. in horizontal plan at the base. General details are given in Fig. 3. Both the anchor bent and the expansion bent are shown in this drawing. The latter consists essentially of two single bents and allows 4 in. expansion of the box girder. The concrete bases on which the bents stand are approximately 5 ft. by 8 ft. with a 7 ft. x 15 ft. footing.

Loading railroad cars from the stockpile is done with a caterpillar-mounted electric shovel, having a 2-yd. dipper. With it they are loading eighty 50-ton railroad cars in one eight-hour shift, which is rather faster than the performance of the steam shovel generally used on such work. The electric shovel, moreover, requires a smaller crew.

Loading for shipment began the first week in May. Plans pursued call for shipping a boat cargo of 10,500 tons each week. Ten days' free storage is allowed at the railroad docks at Marquette. The freight rate to Marquette is 54c. per ton, to which must be added a dock charge of 10c. per ton.

The most prominent part of the surface plant is, of course, the headframe, a steel four-post structure, 124 ft. 8 in. high from collar to center of sheave. It is partly inclosed with corrugated sheet-iron siding, painted freight-car brown. In it, mounted on timbers bolted to the steel frame, is a gyratory crusher, set to crush to 2½ to 3 in. The crushing head has a motion parallel to its vertical axis. The crusher is driven by a 75-hp. induction motor (440 volts, 3 phase, 60 cycle, 870 r.p.m.) with a seven-rope V-belt drive.

As all machinery is electrified, to omit the substation would hardly be right. Its location can be seen in Fig. 1. It consists of a 22-ft. galvanized steel tower furnished with oil-circuit breakers, master switches, lightning arresters, choke coils, and three 500-kva. transformers. The whole is surrounded by a wire fence. Here power purchased from the Cliffs Light & Power Company at 30,000 volts is stepped down to 440 volts. Two smaller transformers, 25 kva., in the electric tunnel of the engine room further transform 440 volts to 115 volts. From the substation all cables and wires are laid in fiber ducts bedded in concrete.

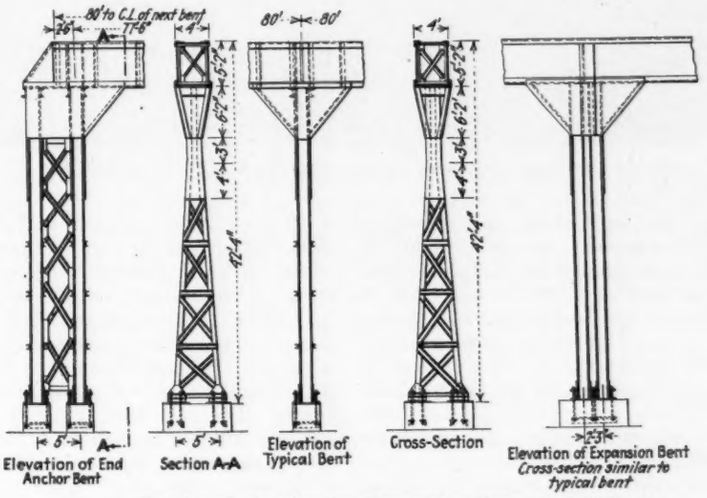
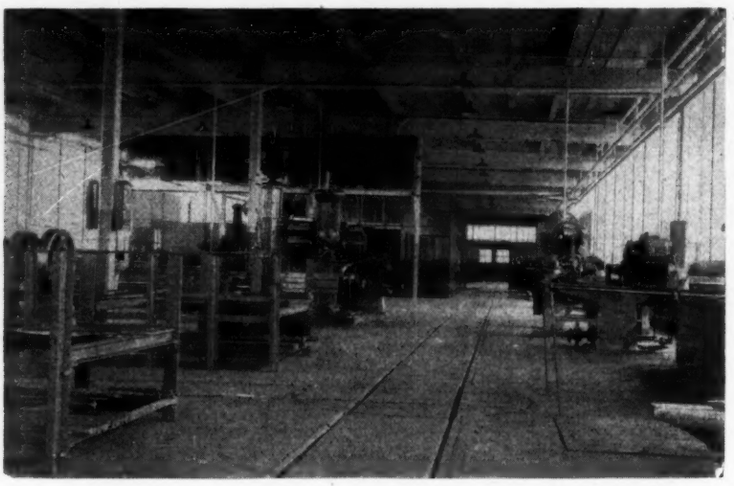


Fig. 3—Details of stocking trestle—anchor bent, typical bent, and expansion bent

THE Blueberry mine, so far as known at present, has one orebody, the width of which varies from 15 ft. to 90 ft. It is cross-faulted in places, and has been explored about 1,500 ft. east and 700 ft. west of the shaft. The deposit is almost vertical, dipping about 84 deg.

north. The shaft is sunk in Siamo slate, ordinarily the footwall. It is vertical, about 350 ft. from the orebody, and approximately in the center along the strike. It is 1,105 ft. deep. The hanging wall is usually a diabase dike. Levels have been opened at 100-ft. intervals, starting at 500 ft., the deepest being the 800 ft. There is no development work below this point except the shaft. Mining is being done above the fifth and sixth. The 700- and 800-ft. levels are developed.

Since the property was leased from the Palms-Book company some diamond drilling has been done to supplement that performed by the latter. Work done comprises about sixteen holes, some as deep as 1,400 ft.



Interior of shop wing, with supply room and garage in background

The shaft has five compartments, one for the cage, two for the skips, one for pipes and cables, and the ladderway. It is 15 ft. x 10 ft. 10 in. in the clear, each skipway being 4 ft. 3 in. x 5 ft. 1 in. inside measurement, and the cage compartment 10 ft. 10 in. x 6 ft. It is timbered with steel shaft sets, placed 5 ft. apart vertically, center to center. Wall plates and end pieces are 6-in. H-sections. The two long dividers are 5-in. H-sections and the two short ones are 8-in. channels. The studdles between the sets are 6x6x½-in. angles. In the stations, the shaft opening is 15 ft. high, to facilitate unloading timber, rails, and pipe.

On opening a level a crosscut is driven to the ore. Drifting is done in both directions along the ore, or iron-bearing formation, and, except in rock, the drifts are timbered and side lagged, an 8-ft. cap and a 9-ft. well-battered post being used and the sets being placed on 5-ft. centers. Timber used on the haulage levels is tamarack; in the slice drifts it is spruce, tamarack, pine, and hardwood. In rock the drifts are arched. When the ore pinches out or otherwise disappears, 6x6-ft. crosscuts are driven right or left, or in both directions to pick it up. At intervals of 100 ft. along the drift, two-compartment (each 4 ft. 4 in. square inside) cribbed raises are put up vertically, either to the level above or to an intermediate point if the ore becomes too lean to work. If rock is encountered, the raise may be deflected somewhat.

Mining is done by ordinary top-slicing in most places in the mine. In one section between the 7th and 8th levels, where the ground is too strong to follow the mat down and the orebody narrow, sublevel stoping is employed.

Where slicing is to be used, an additional raise is first put up midway between each pair of raises previously driven on 100-ft. centers along the orebody. This will go to the height of the highest sub to be opened, and serves to cut down the scraping distance to the raises on the sublevels. The sublevel drifts are then driven connecting the raises. Slices are taken at 11-ft. intervals, the topmost sub being some multiple of eleven, depending on the height of the ore. Thus, the thickness of the first (topmost) slice may vary from 11 to 20 ft. If thick, the first slice is taken out by drifting up at intervals, and, on the retreat, shooting down the back and taking out half the pillar on each side. Slicing is begun at the extreme end of the orebody from the drifts connecting the raises, the slice drifts being driven right and left at 90 deg. These are timbered with sets on 5-ft. centers, each set consisting of an 8-ft. cap (8 to 10 in. at large end) and 9-ft. posts without batter. At times, two slices are allowed to remain open. Before shooting the posts, a flooring of hardwod mine boards is laid on poles. Where starting a stope, 1-in. boards are used to give a better and firmer mat.

Raises were formerly driven with their long dimension parallel to the drift. Now they are being turned at right angles to the drift, with the manway on the inside to give greater safety to a man getting off a ladder. Chutes in the dirt compartment have double chute irons, with 2x6-in. stoppers, where the dirt is wet; otherwise only one row and a single additional stopper on the outside. When men are working in the raises the chutes are not pulled—this as a safety measure.

Ore is moved in the sublevels principally with a 42-in. box-type scraper, having a blade of ordinary steel equipped with teeth. Blade teeth and corners are stellited. Fifteen-horsepower tuggers are used with these scrapers. In places a 36-in. scraper with a 10-hp. hoist is used. Two 7½-hp. scraper hoists are also in service. In all, seventeen scraper hoists are employed. A grizzly of rails, with a 1-ft. opening, is used over the raises in the sublevel drifts. Any popping is done in the face.

Sublevel stoping is under way in one section of the mine where the capping is too strong to follow a mat down. The one stope worked by this method was started at a development raise put up to the capping from the main level. Thirty-four feet above the latter, the main sub was opened, and above it at 15- to 20-ft. intervals the stoping or dog drifts were driven. The main sub, which serves as a scraping or transfer drift, and the first drift above it are connected at 15-ft. intervals by 5-ft. untimbered raises staggered on opposite sides. These raises are started in the walls about 45 deg. for the first round and then turned sharply upward to connect with the drift above. They serve successively as ore passes to the transfer drift, as the face of the stope progresses away from the starting raise. The transfer drift is timbered with 8-ft. caps and 8-ft. posts. The stope drifts are 6x6 ft. and untimbered.

In drilling in ore, auger drills are used with diamond-section auger steel. Thirty of these machines are in service and about 4 tons of steel, the consumption of the latter running about ½ ton per month. Sixteen to twenty holes are drilled, depending on the ground, in driving sublevel drifts, the round being 6 ft. deep. The auger steel comes in 10-ft. lengths, 10 in. of which is shank. A center cut is used. In the slice drifts only eight holes are drilled and these in the lower half of the breast, the upper half readily coming loose from the boards, or else being picked or popped down. The ore is rather tough in general, so that the drilling is somewhat harder on the average than in other soft-ore mines on the range. Blasting is necessary, the use of picking being somewhat limited.

In rock drifting, N-72 drills, mounted on a bar, are used, best results being secured with two drills and three men. Six of these are in service. In the main haulage drifts, 24 6-ft. holes and a center cut are used. A 5-ft. round is pulled per shift. The steel is 1¼-in. hollow round, with a cross bit and 14-

deg. taper. A 2-ft. starter is used with 1-ft. changes up to 6 ft., the gage dropping ⅛ in. with every other change. The steel is received originally in 16- to 18-ft. lengths. No block test is made. In drifting on the main levels, mucking is regularly done with a track-mounted scraper slide, accommodating one 76-cu.ft. car, and having a 10-hp. hoist mounted on the front end of the slide. With this is used a 30-in. box-type scraper, having a ½-in. pull rope and a ⅜-in. tail rope.

In raising in rock or in hard ore, ⅞-in. hollow hexagon steel is used in an auger drill having an air-feed stoper leg.

Blasting in ore is done with a 45 per cent low-density powder. In rock a 60 per cent low-density powder is employed. No. 6 blasting caps and ordinary fuse are used, the fuses being spit with a so-called "hot wire." This is sufficient for lighting sixteen fuses, the maximum that is permitted to be spit by one man. Primers are all 6 ft. long, except that when a raise exceeds 50 ft. in height, 7-ft. fuses are used. All primers are prepared with a safety fuse-crimper. In main-haulage drifting, holes are loaded for about five-sixths of the length, no tamping being used. In slicing, about two-thirds of the hole is loaded, also without tamping. All blasting is done at the end of the shift by miners, except popping, which is done at lunch time. Smoke is blown freely after blasting, the large compressor running for half an hour after the shift comes out.

THE 500, 600, 700, and 800 levels are equipped for main haulage. Cars used are of the rocker-dump type and have 76-cu.ft. (4½-ton) capacity. The ore is very wet. It runs about 16 cu.ft. per ton broken. Track grade is 0.5 per cent, and the minimum radius of curves 50 ft. Cars are hauled six to a train by 6-ton locomotives, of which there are three. These have a trolley pole having its base on a movable arm so that the lower end of the pole may be swung to either side of the motor, thus increasing the radius within which the trolley can take its power. No gathering reels are used. The average tram is about a quarter of a mile. A storage battery locomotive is used in development work. Tracks are of 40-lb. rail, 30-in. gage. Car wheels of both cast iron and steel are used.

Cars dump into two small skip pockets at the shaft, one car only to a pocket. The skip is of 80 cu.ft. capacity, being slightly larger than the car, and dumps at the top into the crusher and thence into the 90-ft. larry car, already mentioned, for stocking.

Shaft guides are fir, and 5½x7½ by 18 ft. in dimensions. The skip shoes are stellited, to prevent excessive wear caused by the ropes being hung 5 in. off center.

The mine has but one opening. To aid the ventilation two blowers, driven by 25-hp. motors, are located on the 800-ft. level. Ducts of 10-in. spiral-riveted pipe, up to 1,000 ft. in length, are used to supply air in driving long development drifts.

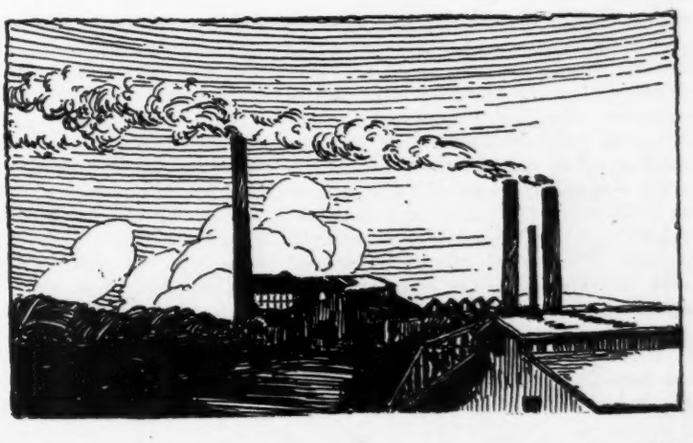
At present 122 men are employed underground, 63 on day shift and 59 on the night shift, the difference being due to the fact that on day shift two trackmen, a powder man, and a pipeman are also employed. Aside from these, the distribution on both shifts is as follows: 45 miners, 3 motormen, 3 brakemen, 1 skip tender, 1 pumpman, 4 spare men, and 2 shift bosses. On the slicing sublevels, 2 men per shift are normally employed in each working place.

The flow of the mine water is about 180 to 200 gal. per minute. Pumping equipment includes two 3-stage centrifugal pumps (500 g.p.m. at 500-ft. head) on the 600 level, coupled in tandem, each being driven by an 100-hp. motor (440 volts, 3 phase, 60 cycles, 1,750 r.p.m.); a similar installation on the 800-ft. level, the two pumps here also being coupled in tandem; a No. 7 air-driven pump below the 800-ft. level to keep the shaft dry (pumping to the 800); and on the 100-ft. level a 500-g.p.m. pump to handle the water from the surface. Water from the 500-ft. level is siphoned to the 600 and, similarly, that from the 700 is siphoned to the 800. The sumps on the 600 and 800 levels are 70x14x16 ft., each having about four-hour storage. The chips are screened before the water enters the sump. Pump rooms have a concrete floor and a track running to sump, so as to facilitate cleaning. All pumps are manually attended.

For fire pumping purposes a pump having a capacity of 750 g.p.m. at 400-ft. head is installed on the first level. It is driven by a 125-hp. motor and may be controlled from the engine room, shaft collar, and pump. It discharges into the 6-in. surface water line. Fire protection to the plant building is afforded by a sprinkler system and by five fire plugs at as many points. A 4-in. water line runs the full length of the timber yard, with hose connections and 50 ft. of fire hose housed in a red-painted metal rack every 100 ft. Fire extinguishers are freely distributed about the plant.

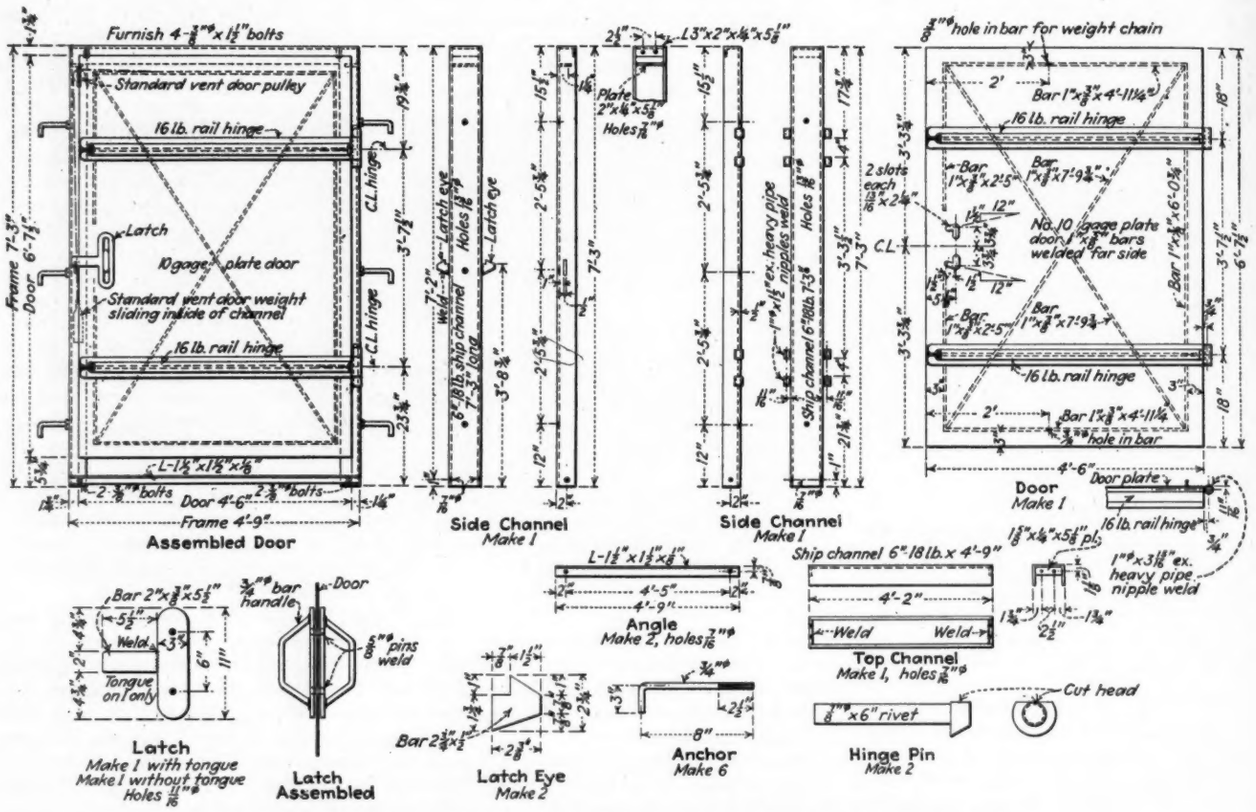
ALL operation, except that of the air-driven pump in the shaft, is electrified. Three circuits are taken underground. Scraper hoists and extension lights, haulage motors, and chute lights are on a 250-volt d.c. circuit. This enters the mine via the shaft, from the motor-generator set in the engine room, as a 500,000-circ.mil, steel-armored, lead-covered and corded cable, entering each main haulage station, where it is tapped on to the 2/0 Fig. 8 trolley wire, with a circuit breaker. For scraper operation, the current is taken from the haulage circuit by a No. 6 rubber-covered flexible conductor to a junction box (on the wall in the haulageway) having a two-way switch, and thence out again to the track. The scraper-hoist current is taken out by a No. 6, two-wire rubber-covered conductor, 50 to 100 ft. long, to a similar switch at the tugger. Here again the circuit may be continued by a similar No. 6 two-wire conductor to another tugger along the line. For lights at the tugger and in the slice, the No. 6 conductor is tapped just above the switch at the tugger. Where using a scraper slide a headlight mounted on the slide is tapped in as described.

Besides this d.c. circuit, there are two a.c. circuits; one is a 110-volt, 3-phase, 60-cycle line for station lighting and signal bells for skip and cage; the other, a 440-volt, 3-phase, 60-cycle line to the pumps. Each of these circuits is carried from the substation on the surface down the shaft in a steel-armored lead- and rope-covered, three-wire cable. The light and bell circuit runs into a junction box in every station and out again down the shaft. On each level it is distributed by a No. 10 rubber-covered wire in a pipe conduit for a distance of 75 ft. from the shaft. The pump circuit to the various levels of the mine runs directly to the pumps.



New-Type All-Metal Ventilation Door

Oscar A. Glaeser



Details of standard all-steel reversible ventilation door developed by United Verde

A MINE ventilation door should be reasonably tight to be of any value in the control of air currents. Wooden doors are commonly used. However, because of the severe treatment a door receives, repairs and replacements are high for wooden doors. When hit by an ore train a wooden door is usually hopelessly demolished. In wet or damp locations such doors frequently warp and the timber rots, so that replacements are necessary. Again, door locations become obsolete. The doors are then removed, but the frame, if it is set in concrete, either stays in place or is cut out. All these conditions tend to make wooden doors expensive.

To remedy as many of these defects as possible an all-metal door was developed at the United Verde mine at Jerome, Ariz., which has so far proved very satisfactory. The accompanying figure shows the details.

The frame is made of three pieces of 6-in. 18-lb. ship channel with the channel turned inward. The cap and posts are bolted together. Two light angle irons bolted to both sides of the posts on the bottom act as spreaders during erection. A catch is welded on each side of one post and double hinges are welded on each side of the other post. A door-weight pulley bracket is welded into the channel near the top of the post with the catch. All assembly bolt holes, catches and hinges are located in identical positions on all frames, so that frames, or parts of frames, and doors are interchangeable. Anchor bolts are provided which hold the frame to the concrete.

The door is made of 10-gage plate stiffened with ⅜x1-in. bars spot-welded to the inside of the door. Two 16-lb. rails are welded horizontally on the outside of the door and connect with the hinges as shown. Hinge barrels are made of 1-in. pipe welded to the door and frame. A concrete sill is used where these doors are installed.

The doors and frames are made complete in the shops and assembled on the job. Being equipped with double hinge and catch the door can be hung to swing either in or out, or by an interchange of posts it can be made to open to the right or the left. To obtain this flexibility it was necessary to design the door so that either end could be used as top or bottom, accomplished by the accurate spacing of hinges and the adoption of a different type of latch. A counterweight is also used and operates in the channel of the post.

Some of the advantages of the door are as follows: The door and frame are removable for use elsewhere should one location become obsolete. The doors are all of standard size and uniform construction and are therefore interchangeable regardless of position or direction of swing. The frame can be assembled and the door hung to suit the conditions of any particular location. In the event of a haulage wreck, the damaged door can be straightened in the shop. In the meantime, another door is hung in its place. Replacements of any part of a door assembly have so far not been necessary. The total cost of a door and frame as made in the local shops is $24, which compares favorably with that of other types of doors used in Arizona copper mines. (See U. S. Bureau of Mines *Bulletin* 330, "Ventilation of the Large Copper Mines of Arizona," p. 126) The door swings easily upon its hinges and closes positively through the action of the counterweight and the free-operating latch. All construction data are presented in the illustration shown on this page.

RUBBER PIPE LINING

Minimizes Pulp Abrasion

D. D. Homer

Contrary to popular opinion, a hard material is not necessarily more effective than a soft one in resisting abrasion. Metal wearing surfaces are now being lined with a resilient material—rubber; and the results are bringing to engineers a new perspective on the theory and practice of abrasion and attrition. The revolutionary character of this innovation is well illustrated in the article here presented. For the transport of tailing a metal pipe lasted for the passage of 1,000 tons; and extra-heavy metal pipe, for 2,000 tons. A rubber-lined pipe shows negligible wear after the passage of about 250,000 tons.

FILLING stopes with classified mill tailing at Pinar del Rio, Matahambre, Cuba, with details of operation and costs, was the subject of an article by George L. Richert, in *Engineering and Mining Journal*, of March 2, 1929. Experiments conducted with standard steel pipe, extra-heavy steel pipe, and rubber hose for passing the sand to the stopes showed that standard pipe was worn out after the passage of about 1,000 tons of sand; extra-heavy pipe lasted for about 2,000 tons; rubber hose was unsatisfactory on account of trouble at couplings and bends. Rubber-lined pipe furnished by the B. F. Goodrich company has proved entirely satisfactory.

Standard steel pipe, with normal flanges, is used, of 3-in. inside diameter, in lengths of 12 ft. A rubber lining ¼ in. thick, vulcanized or welded to the inside of the pipe by the special Goodrich process, is brought out over the face of the flange as shown in Fig. 1, thus acting as a gasket to prevent sand from wearing its way into the joint between rubber and pipe, a feature of great importance. If plain pipe ends are butted together or joined by some flexible coupling, the sand will eventually wear a passage between the rubber lining and the pipe.

Rubber-lined pipe of this type has been in service since February, 1929. Two main lines of 3-in. pipe lined with ¼-in. rubber, of 2½-in. effective inside diameter, have been installed to transport sand from the classifier down the raise to the different levels, one of these lines serving as a spare unit. Branch lines are run to all stopes on every level. Sand is diverted to any level by taking out a length of pipe in the main line and inserting a curved length, which is connected with the branch line. This eliminates all valves and tees. The same method is used in connecting stope lines with the branch lines.

These lines have handled 35 tons of sand per hour without difficulty, and the capacity is apparently still higher. During the period from February, 1929, to June, 1931, inclusive, 205,400 tons of sand has been put through the pipe. Wear on the rubber, as shown is the accompanying illustrations, is practically negligible on straight lines. One curved length recently removed had a small hole worn through at the bend. More than 200,000 tons of sand had passed through the pipe at this point.

Average cost per ton of sand placed in stopes during the last six-month period is as follows: Labor, 10.5c.; burlap, 4.8c.; pipe, 7.1c.; pump, 0.6c.; power, 2.0c.; total 25.0c. The cost of $0.071 for pipe includes all new pipe lines installed. As no replacement of pipe has been made, the actual cost per

Screen Analysis of Tailings

Sizes, Mesh	June, 1931 Mill Tailing Per Cent	Cum.	July 16, 1931 Sand Fill Per Cent	Cum.
+ 20	....	....	0.05 (wood)	0.05
+ 28	1.4	1.4	1.4	1.45
+ 35	5.0	6.4	8.2	9.65
+ 48	9.2	15.6	16.1	25.75
+ 65	11.2	26.8	18.1	43.85
+100	10.6	37.4	28.1	71.95
+150	8.0	45.4	6.4	78.35
+200	6.8	52.2	9.5	87.85
—200	47.8	47.8	12.0	12.00

Solids in mill tailing, per cent	27.2
Solids in sand fill (classifier discharge), per cent	71.5
Solids in classifier overflow, per cent	24.9
Tailing discharged as slime from bowl classifier, per cent	45.7
Tailing discharged into mine as sand fill, per cent	54.3
Sand fill discharged by classifier capacity, tons per hour	25.2
Water added to sand fill as discharged to mine pipe line, g.p.m.	.40

June, 1931, Results

Total mill tailing, tons	25,854
Tailing to bowl classifier, per cent of total	66.1
Feed to bowl classifier, tons	17,086
Tailing to classifier discharged as mine fill, per cent of total tailing	54.3
Sand fill to mine, tons	9,275
Solids, including classifier overflow and tailings, pumped direct to tailing pond, tons	16,579
Mill tailing placed in mine as sand fill, percentage of total tailing	35.9

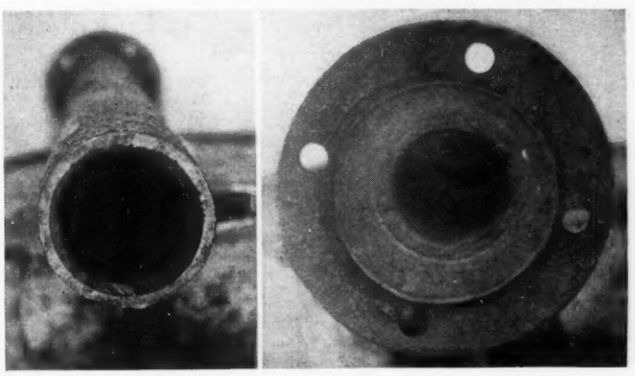


Fig. 1—Rubber-lined pipe. Left, cross-section through pipe; right, end view showing flange

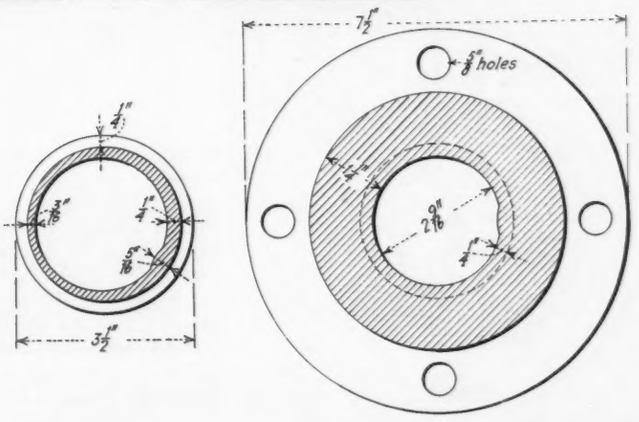


Fig. 2 — Sketch showing dimensions of rubber-lined pipe. Left, cross-section; right, flange end

ton of sand placed in the stopes probably does not exceed 20c.

A new method of grinding was adopted in the concentrator after the completion of the original pipe installation. Screen analysis and other operating data are compiled in the table on the preceding page.

A present development drift in the mine has advanced to a point where a raise may conveniently be driven to the surface immediately below the mill. Plans have been made to drive this raise, and to move the classifier to the foot of the mill, whereby the power cost of $0.02 per ton will be saved. Actual cost per ton of fill in stopes should thus be brought below $0.20. No other changes have been made in the system described in the article to which reference was made.

No surface fill is used at Matahambre, as all fill is furnished by development and mill tailing, the amount of tailing depending on requirements after disposal of the waste. Not all tailing produced is used at present, on account of the necessity of disposing of the waste underground. To hoist this waste is not convenient, as dump space near the shaft collar is lacking. When the new No. 2 shaft is in operation, hoisting of more waste and an increase in the proportion of sand fill will be more economical.

Previous to the introduction of sand filling, fill had to be obtained from glory holes. This fill consisted of decomposed shale and was so wet and sticky that it was difficult to handle. This was the only available fill aside from the development waste, and mine production was therefore limited to the amount of surface fill that could be placed in the stopes.

Total reduction in cost per ton of ore mined, resulting from the convenience and economy in using sand fill, and the increase in production made possible by this method of filling, has amounted to over $1 per ton, or between $350,000 and $400,000 annually during normal operations.

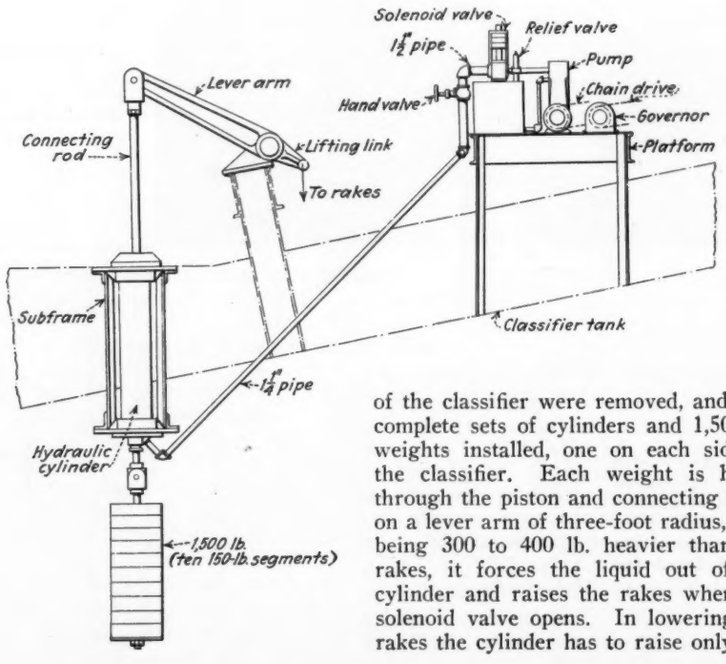
■ ■ ■

Classifier Lifting Device

MOST of the engineers in the mining industry feel at one time or other the need of having some non-automatic operation around the mine, mill, or smelter performed automatically, writes J. W. Prendergast, of Denver, Colo. Such a situation prevailed at the Climax Molybdenum Company's mill at Climax, Colo., whenever one of the frequent power failures occurred, which meant that the sand had to be cleaned out of the 16x24-ft. Dorr QSD quadruplex classifier, so that the rakes would be free and the device could be placed in operation again.

The problem of devising a satisfactory method of lifting the rakes out of the classifier was referred to The Dorr Company. After considerable investigation the following five methods were suggested: (1) rakes raised by a counterweight in conjunction with a hydraulic cylinder, and then returned to the operating position, using a liquid and a pump; (2) rakes raised by a counterweight in conjunction with an air cylinder, and then returned to the operating position, using compressed air; (3) a combination of methods 1 and 2; (4) a 6-in. Pelton wheel, with automatic valve in place of a handwheel; (5) a d.-c. motor, with automatic switch, battery, and charger in place of a handwheel. The first method was approved by A. J. Weinig, consulting engineer for the Climax Molybdenum Company, and by technicians of The Dorr Company. All parts of the raising device were then rechecked, slight changes in design being made to facilitate their manufacture.

The handwheel, worm, and segment of the classifier were removed, and two complete sets of cylinders and 1,500-lb. weights installed, one on each side of the classifier. Each weight is hung, through the piston and connecting rods, on a lever arm of three-foot radius, and, being 300 to 400 lb. heavier than the rakes, it forces the liquid out of the cylinder and raises the rakes when the solenoid valve opens. In lowering the rakes the cylinder has to raise only 300 to 400 lb., the rest of the total load being counterbalanced.



The pipes from the cylinders to the reservoir are of equal length and 1¼ in. in diameter, and the pipe leading into the reservoir is 1½ in. to allow for the combined flow from both cylinders. The cylinders work simultaneously, owing to the equal length of piping to each. A subframe attaches the cylinders to the side of the tank. On top of the classifier is a platform that supports a Reeves drive. This platform was extended the full width of the classifier tank, and the reservoir, pump, and Cutler-Hammer governor were installed on it. The pump and governor are driven through a chain drive by the drive shaft of the classifier. The solenoid valve is mounted above the reservoir and connected through the governor to the power line.

Liquid from the reservoir is forced by the pump through the solenoid valve to the cylinder, raising the counterweight and lowering the rakes. When the rakes are lowered, a spring-release valve bypasses the excess liquid back into the reservoir, safeguarding the Myers pump, which has a capacity of 3½ g.p.m. at 300-lb. pressure. A constant pressure of 70 lb. holds the rakes in operating position. If the flow of electric current is interrupted, the solenoid valve opens and allows the liquid to drain into the reservoir. The weights raise the rakes by the time the classifier has come to rest. Should some part of the classifier break, the governor would stop the flow of current to the solenoid valve before motion of the machine could cease or speed up excessively, the rakes being raised, as a result of the interruption in the flow of current.

Owing to the small capacity of the Myers high-pressure pump, the rakes are lowered slowly. This enables the rakes to clean the tank as they descend. Raising and lowering of the rakes is controlled by hand valves. Water, light oils, or non-freezing preparations can be used with equal success in the device, depending on climatic conditions.

Moving an Iron-Country Headframe

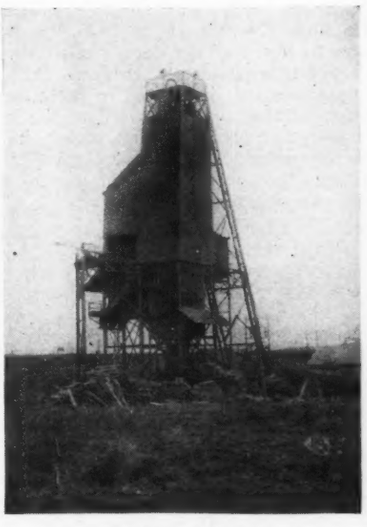
Utica headframe, March 21, 1931, nearing the end of its ½-mile journey over frozen muskeg. The objective is the shaft over which stands the sinking headframe a few hundred feet beyond

A STEEL HEADFRAME 90 ft. high, weighing 90 tons and standing over a shaft of the Utica mine, near Hibbing, Minn., was moved, during March, 1931, about a quarter of a mile across a muskeg swamp to a new shaft on the Utica Extension. Both properties are managed by Pickands, Mather & Company for the Crete Mining Company, lessees, the fee in each case belonging to the Great Northern Iron Ore Properties. The work of moving was done by a contractor. Because of the season, the swamp was frozen. The past winter was one of the mildest on record, however, in the Lake Superior iron country, and this unusual condition increased the otherwise negligible risk of breaking through the muskeg. Two halftone reproductions presented herewith show the headframe, one of them while it was midway on its journey and the other after it had arrived in its new position.

Preparatory to moving the headframe, daps were cut in the outer edges of the steel posts about 6 ft. above their bottom ends. In these were set the flanges of 80-lb. rails, which were then clamped by U-bolts to the posts, on all four sides of the frame. The ends of these rails extending beyond the frame were rested on 16x16-in. timbers 80 ft. long. Headframe, rails, timbers and all, as a unit, were then jacked up with 25 screw and hydraulic jacks, and moved on rollers on two tracks, one on each side, built of 8x16-in. timbers, across the swamp. Guy ropes from each top corner to the ends of the 80-ft. timbers steadied the structure in moving.

The collar of the shaft on the Utica ground was about 12 ft. higher than the swamp. Levels were given by the engineers continually during the work of moving. The timber track was kept at the same elevation as the starting point until the lowest point of the swamp was reached, being carried on cribbing. Then the headframe was lowered the 12 ft. difference of elevation, and the moving continued. On nearing the new shaft, the headframe had to be raised 6 ft. and swung 90 deg. Six-inch wooden rollers were used in moving, which was accomplished with the aid of a team of horses, a capstan, wire ropes, and blocks.

Three weeks were required to make the change. This was completed by simply changing the rope from the temporary sinking headframe to the new one. Moving was considerably cheaper than to dismantle and re-erect. Practically no delay was caused to the shaft-sinking work then in progress, the shaft at the time being down about 150 ft.



The headframe on its new site, early in May

Personal Notes . . . Comment . . . Criticism

J. Wilkerson, mining engineer, who recently returned from Rhodesia, is now at Cananea, Sonora, Mexico.

C. O. Newton is now manager of mines for the American Fire Clay Company, operating at San Juan Capistrano, Calif.

E. J. Bell, who is in the employ of the Soviet government, is expected to return to Bisbee, Ariz., from Moscow early in January.

Jackson A. Pearce is requested to send his address to the editorial department, *Engineering and Mining Journal,* 330 West 42d St., New York.

R. V. Ageton, of the Conservation Branch, U. S. Geological Survey, has left Washington, D. C., for his new headquarters at Carlsbad, N. M.

James Park, for the last 30 years dean of the mining faculty of the University of Otago, at Dunedin, New Zealand, has resigned from that post. Mr. Park is the author of several textbooks.

William E. Smith, metallurgical engineer for The Dorr Company, with headquarters in Salt Lake City, was recently transferred temporarily to the sanitary engineering division of the same company, with headquarters in Chicago.

H. Foster Bain has resigned from the secretaryship of the A.I.M.E., effective Nov. 1, to act as Managing Director of the Copper and Brass Research Association in a five-year program of technical research to expand the uses of copper and brass.

Major Charles F. Williams, mining engineer with the U. S. Geological Survey, has been authorized to use a privately owned airplane on official business trips in connection with his work as district mining supervisor with headquarters at Miami, Okla.

Arthur B. Parsons has been appointed Secretary of the A.I.M.E., beginning Nov. 1, to fill Dr. Bain's unexpired term. Mr. Parsons has been Assistant Secretary of the Institute for the last year or two, and a few years ago was Associate Editor of *Engineering and Mining Journal.*

Howard N. Lary, a graduate of the Massachusetts Institute of Technology, author of the article on page 353, is assistant geologist of The Empire Zinc Company, at Gilman, Colo. All exploratory operations of the company at Gilman are directly under his supervision.

H. J. C. MacDonald, of Denver, Colo., chief mining engineer consultant to the Giprotzvetmet in the projection, administration, and exploitation of mines and plants in the U.S.S.R., was awarded a $7,500 prize recently by decree of the Supreme Economic Council, in recognition of his work.

Robert W. Karpinski, mining geologist, has just returned to the United States after receiving the degree of doctor of science from the Université de Nancy (Ecole de Géologie Appliqué). He has recently spent three years in French Indo-China in charge of prospecting for the Union Financière Privée, of Paris. His temporary address is Ann Arbor, Mich.

J. M. Burnell, a resident of Kansas City, now vacationing in Denver, evinces interest in the article in the Aug. 10 issue on the operations of the Empire Zinc Company at Gilman, Colo. Mr. Burnell adds: "In 1884 I sold the Iron Mask and Little Bell locations to a Mr. W. F. Lay. He developed the property, and largely from its developments the wonderful disclosures have been made of the orebodies on Battle Mountain. In further comment, permit me to say that I crossed the plains in a wagon eight years before the arrival of railroads, arriving in Denver on May 22, 1862, a boy nearly eleven years old at that time."

Corbin T. Eddy, assistant professor of metallurgy and head of the department of physical metallurgy at the Michigan College of Mining and Technology at Houghton, has been awarded the Alfred Nobel prize for Science in the newly established Junior division for men under 30 years of age. His paper which won the award is "Arsenic Elimination in the Reverberatory Refining of Native Copper," delivered at the meeting of the American Institute of Mining and Metallurgical Engineers in New York City last February. Presentation of the award will take place at the next annual meeting of that body in February, 1932. Corbin T. Eddy is the son of Mr. and Mrs. Samuel Eddy, of Lake Linden, Mich. He was born in 1904, and received the degrees of bachelor of science and engineer of mines from the Michigan College of Mining and Technology in 1926. A year later he obtained the degree of master of science in metallurgy. In June, 1927, he was appointed instructor in metallurgy. Last October he was raised to the rank of assistant professor and given charge of the division of physical metallurgy within the department of metallurgy and ore dressing.

Pump Plunger Repair

To the Editor:

I have read with interest your short article on pump plunger repair, which appeared in a recent issue. Your readers may be interested in knowing that the idea involved dates back 21 years, to the summer of 1910. At that time large triplex pumps were used at the Nacozari concentrator, for pumping return water. The 10-in. plungers were fitted from the factory with large brass bushings, costing about $100 each, which were renewed when worn. In an emergency, when the supply of bushings had been allowed to run out, 10-in. pipe was used as a substitute, and was found to work equally well. A substantial reduction in cost was thus accomplished, a fact much appreciated by Ed. Buckley, the mill superintendent, who had gained a reputation for efficient and economical operation. A. Versteeg was master mechanic, and as I was running the only lathe in the small shop at that time, I was given the task of boring out the first bushings used.

ERNEST MAURER,
Master Mechanic,
Ergasteria Flotation Company.
Laurium, Greece,

Gold in Southeast Peru

To the Editor:

Only recently my attention has been called to a letter, published in a recent issue by my old friend Lester W. Strauss, in which he belittles the gold fields of southeast Peru. As one of the pioneers of that region I come forward to demonstrate that Mr. Strauss, whose good faith I well know, has been misinformed.

In January, 1897, I was appointed engineer in charge of the exploitation of the Santo Domingo mine, acquired by the company of that name six months previously. For two years I made a careful and complete study of the property, which to date has produced gold worth over $10,000,000. My report was published, 1898-99, in the Bulletin of the Lima School of Engineering; my predictions have been proved correct. Knowledge of the Santo Domingo mine and observation of the Indian gold farms induced me to amplify my study of the region in the fields, and through the publications of reliable authors, from the early historians of the Colonial Period. I thereupon concluded that the gold fields of southeast Peru, situated in a Silurian basin of enormous area, were exceptionally rich, and that their exploitation would, some day, surprise the world. In 1900 I obtained, together with a French promoter of mines, a concession from the Peruvian government, to dredge the Inambari River and its affluents. On the basis of my reports, we were able to float, in England, in 1903, the Inambari Gold Development Corporation of Peru, Ltd. An engineer of high standing, Hugh Seed, with experience in dredging in the West Coast of Africa, reported favorably on the concession, which report was later confirmed by Inner & Henderson, of London, a firm of consulting engineers.

The dredge, erected by the company at Oroya, near the Santo Domingo mine, was lost, not by a flood but by the caprice of the manager, who, trying to move it to a site down the river he thought richer, ventured to shoot a rapid and sank it.

The second dredge was sent out by the

Inambari Gold Dredging Concession, a successor to the aforementioned company, and erected near the confluence of the Inambari and San Gaban rivers. This dredge worked only a few days in the outer edge of a sharp curve of the river, where the velocity of the stream did not permit the gold to settle, and therefore results were unfavorable. Why the management started work in such a place is unexplained. The Inambari River, the great artery of the region, is like a sluice placed by Nature to collect the gold carried into it by numberless affluents and sub-affluents.

For ten years more I continued my studies of the region, having reported on seven different properties. My opinion on the great possibilities of the gold fields has been further strengthened, but as facts are more reliable than words, I will conclude with the old saying, *qui vivra verra*—he who lives will see.

Lima, Peru. FERNANDO FUCHS.

Conservative Development of Gold Prospects

To the Editor:

Mining engineers are well advised in turning their attention toward gold deposits at present. Many prospects are available, but to insure success a competent engineer should guide their exploitation.

In prospecting for gold ore, I believe the old localities offer the best opportunities. An old mine, formerly a producer, may again prove profitable. A new vein may be found in such a locality. For example, at Manhattan, Colo., a gold-bearing dike was recently discovered, the gold being associated with pyrite uniformly disseminated through the dike. The dike assays an average of $10 over 4-ft. width. It will average this width and it intersects another dike about 40 ft. wide. At this junction, on the hill top, the ore assays over $20 per ton.

This dike lies in a district that was the scene of a gold boom during the last century. The old-time miner in his hectic search for free gold never glanced at such a dike. Enough tests have been taken to indicate the dike may develop into a large low-grade orebody, as a large tonnage has been blocked out on three sides by weathering and erosion. Prospect tunnels are being driven to test the orebody at depth. The entire hill is highly mineralized and cut by small veins and dikes.

Orebodies such as have here been briefly described will yield a profit if conservatively developed and mined by the engineer. A concentrator, simple and not too large, and a small but efficient crew are all that is required. It is not good policy in such instances to invest in a large mill when a small one will return a fair profit on a small capital outlay. Many partly developed mines owe their ultimate failure to enormous expenditures to obtain mass production.

The engineer pursuing a conservative policy such as described will be rewarded with success more quickly than by huge development expenditures. A mine is successful only when a profit is made.

Denver, Colo. JOHN W. PRENDERGAST.

Pre-Cambrian Publicity

To the Editor:

For many years it was my privilege to be a member of the Canadian Institute of Mining and Metallurgy. I frequently attended its meetings, as well as the Empire Mining Congress held in Canada in 1927. I have therefore heard Mr. C. M. Campbell on several occasions discuss the mineral resources of Canada, particularly those of the Pre-Cambrian area. While he is evidently a pessimist, I have nevertheless been impressed by his good sense and honesty of purpose, feeling that his often extreme views may act as a wholesome corrective upon those disposed to lean too far the other way.

Mining and mineral development is a human activity that requires vision and an active imagination, else it fail of success. But these mental factors must be controlled by common sense, honesty, and sound technical knowledge. Canada has been fortunate in possessing many distinguished mining engineers and geologists, men largely trained in its own universities. The Dominion may be well proud of them, for they are second to none. No doubt their views have been necessarily circumscribed and restrained by the fact that Pre-Cambrian geology is notoriously difficult of interpretation. No one was more conscious of that fact than my old and lamented friend the late Dr. Willett Miller, whose skillful work did so much for Ontario.

Prospecting in this vast area of eastern Canada was very difficult until the advent of the airplane and the development of efficient geophysical methods of locating orebodies, which methods even at their best have serious limitations. But Canada has given us some notable surprises, such as Cobalt, Porcupine, Kirkland Lake, and most of all the nickel-copper deposits of the Sudbury district. No doubt these remarkable discoveries have given rise to periods of wild, uncontrolled speculation, disastrous to the people who indulged in them and, incidentally, giving mining a bad name. This has made it difficult to finance new enterprises and hindered the development of the country.

Mr. Campbell's remarks concerning the mineral limitations of the Pre-Cambrian are seemingly justified, for the granites of this vast area when unassociated with the Huronian have generally been disappointing as far as my own experience is concerned. And in this connection I cannot refrain from mentioning a joke on myself. Some years ago I was notified and honored by the Ontario government by having one of the new townships south of Abitibi Lake named for me. I confess to have had visions of a new Porcupine or Kirkland Lake, only to find that, though some gold had been discovered in the township, most of the area was either covered by glacial detritus or underlain solely with barren granite. However, as several of the neighboring townships were named for distinguished geologists and mining engineers, I have the comfort of good company. It does not seem that Pre-Cambrian areas in other parts of the world have been generally conspicuous as mineral producers, although certainly there are perhaps many notable exceptions.

I wish I could agree with the optimistic views of my friend Foster Bain regarding the potential supply of undeveloped resources at relatively great depths. Unfortunately, mineral deposits have a habit of often petering out before as much as 5,000 ft. is attained. I do not, however, refer to the Witwatersrand gold deposits or beds in the Transvaal, Union of South Africa, which are unique and unlike anything so far discovered elsewhere in the world. They are infolded sediments that have been mined to a vertical depth of nearly 8,000 ft., which for various technical reasons is probably the workable limit. The original source of the gold in these beds is a controversial subject, supported on both sides with apparently good and sound theories.

On the whole, mineral deposits the world over are relatively rare. Metallic minerals in minable quantities are infrequent, and in this intensely mechanical and industrial age are likely to be rapidly exhausted. This fact leads me to believe that all minerals ought to belong to the public, to be treasured and rigidly conserved, for they are a wasting asset and can never be renewed or regrown like agricultural products or plant life. In other words, the people of the countries in which they occur should possess an inalienable interest in them, a direct share in addition to the indirect advantages coming from their operation as wages and the general benefit to the public by their exploitation. This is of course no new doctrine, but it is not often recognized in English speaking countries, although today the greatest mineral producers of the world.

The economic interests of the United States and Canada are so closely interwoven that what affects one must be of vital interest to the other. So far as mining is concerned, the same might almost be said of South Africa. The mineral resources of Canada are certainly not illimitable and inexhaustible, nor are those of any other country. A mining engineer or geologist ought to know better than proclaim such views, otherwise he is doing the public and his country poor service. To such men we have to look to know the truth, as far as it can be determined. Therefore we should regard Mr. Campbell's observations with serious consideration, even if we do not always agree with him. His mistakes are those of an honest man seeking to make known the truth and to save the public from foolish speculations and investments, not to mention a national complacency likely or possibly ill founded.

Westtown, Pa. F. LYNWOOD GARRISON.

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Obituary

Howard W. Kitson, geologist, died at El Paso, Tex., on Aug. 7. He was 48 years of age, and a graduate of the School of Mines, Columbia University, Class of 1909.

C. F. W. Kup, managing director of the St. John Del Rey Mining Company, operating in Brazil, and in the employ of that company for 36 years, died on Sept. 29. He was 54 years of age.

Everett J. Hall, of the faculty of the School of Mines, Columbia University, died in New York on Sept. 2. He was 54 years old. Mr. Hall had a long experience as a consultant, especially in the development of a process for obtaining potash, and on making metal powders.

Theodore H. M. Crampton died suddenly at his mother's home in Santa Monica, Calif., on Sept. 30, at the age of 41. He leaves a wife and five children. He graduated in 1914 from the Colorado School of Mines, and soon thereafter joined his brother in forming the engineering firm of Crampton & Crampton. Later he was active in Arizona and Nevada, and was on the staff of Thomas Campbell before and after he was Governor. He designed and erected the Swansea, Ariz., smelter for the Senator Clark interests, and was active in the development of mines around Ely and Pioche, Nev., particularly those of Goodsprings. With his brother, he opened the Boss mine, said to be the only profitable quartz-platinum mine in the United States, and developed a simple and accurate method for assaying metals of the platinum group. Mr. Crampton had an inventive mind and was responsible for a new type of laboratory high-temperature furnace, and for the development of pre-formed asphalt-saturated felt planks for bridge floors and road work. For five years past he had been with Johns Manville, resigning recently to rejoin his brother's firm.

Courtenay DeKalb —An Appreciation

The death of Courtenay DeKalb, on Sept. 2 last, has taken from geology and technical journalism an outstanding figure, and from the Southwest one of its loved and respected citizens. In his profession as mining engineer he was imaginative and bold, ever ready to try new ideas that seemed to him to be logical. As a writer he was noted for his fearlessness and authoritativeness, with a unique, suave style. His many writings on mining and engineering literature included textbooks and other works, as well as numerous monographs and articles. He was a great admirer of Spain and Spanish literature, and one of his ambitions was to complete a biography of Carlos III of Spain, king during the time of the American Revolution. He was a guide, philosopher, and a friend to his young students.

DeKalb, who was born in Loudon County, Va., on Sept. 18, 1861, practiced mining engineering in the West, and in Mexico, Spain, Morocco, and South America, engaging in expeditions of research and exploration in Brazil, Peru, Ecuador, and Central America. From 1895 to 1898 he was professor of mining engineering at the University of Missouri, and for three years thereafter at Queens College, Kingston, Ont. He then returned to the field, managing the San Fernando mine, at Durango, Mexico, and the Exposed Treasure mine, in California, for one year and three years, respectively.

Continuing to travel and to alter the manner in which he applied a scientific training and practical experience, Courtenay DeKalb served as associate editor of *Mining and Scientific Press* in San Francisco; president and general manager of the Pacific Smelting & Mining Company at Guaymas, Mexico; Trade Commissioner of the Department of Commerce for investigating the mineral resources of Spain, Portugal, and Morocco; consulting engineer at New Orleans; professor of mining engineering at the University of Alabama, 1925-26; and investigator in Spain and other countries for the St. Joseph Lead Company. He was a member of the leading engineering societies and the National Arts Club of New York. In 1913 he married Miss Frances Douglas, of Cornwall, Conn., well-known translator of Spanish authors, who survives. Mrs. DeKalb's wifely devotion, and the comradeship that existed between them, were the chief stimuli that effected convalescence after Courtenay DeKalb's health broke down in 1925, thereby prolonging his beneficent usefulness

No man of his calling could be more acutely missed. Always ready to help in the serious work of the world, a scientist of the highest intellectual honesty, Courtenay DeKalb was a dear comrade, a charming host, and an inspiration to his numerous friends, young and old.

JOHN B. HUTTL.

Alfred James—an Appreciation

The untimely death of Alfred James at Johannesburg on Sept. 5 last removes from the ranks of prominent international metallurgists one who was a virile and provocative figure throughout a professional career devoted in large measure to the application and development of the cyanide process, the early success of which is to be credited mainly to his energy, aggressive action, and inventiveness. It was James who overcame the insistence of MacArthur, the inventor of the process, that its main application was for the treatment of refractory ore and concentrate. A demonstration of the practicability of the first large leaching vats, erected by James at the Robinson mine, forced attention to the scope of the process in its application to stamp-battery tailing.

A debt of gratitude is due to James for his generosity in making available, promptly, knowledge acquired by experience during his early professional travels in New Zealand, Africa, and the United States. In 1901 he published "Cyanide Practice," one of the earliest textbooks on the subject. For many years he wrote an interesting and stimulating "Christmas Letter," which he circulated among his friends and associates. This discussed trends and tendencies in the application of the cyanide process throughout the world. It was critical as well as commendatory. The last few "letters" were published first in this journal, the valedictory appearing in January, 1930.

Alfred James was a loyal and consistent champion of the technical press. He was appreciative of the assistance it has been in the promotion of improved engineering methods, but regretful that published facts and opinions were not fully utilized. Writing from Johannesburg in June last, he commented on a discussion overheard there between two prominent engineers, who deplored the lack of information on a subject already fully discussed in this publication, which, James added, "they had apparently not troubled to read." His last letter to be received, written in July, was in approval of an editorial averring that "Technical Writing Is an Engineering Task." "You may not agree with me in thinking that the study of Greek is a good preliminary to a training in engineering," he added, "but it teaches that every little particle, or modification in the shape of a thing, has its special significance."

Alfred James' passing reminds one of an important group of pioneers in hydrometallurgy, who donated to the profession of mining engineering a heritage of metallurgical technique the successful evolution of which was mainly the result of a liberal and progressive policy of frank publicity. As one of James' associates in the first application of the cyanide process at the Salisbury plant, W. A. Caldecott, wrote to me in 1924: "It is difficult for the metallurgist of the present day to realize that the knowledge upon which he draws did not exist in our time; and that, inasmuch as he owes it to the work of others, so in turn it is his duty to contribute to the common stock such items of further progress as he may be responsible for, for the benefit of his fellow workers and those who come after."

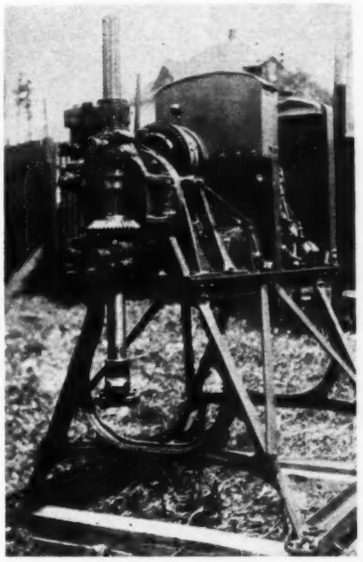
As was the case with many other engineers, my association with Alfred James was engendered and stimulated by a mutual interest in metallurgical problems and technical progress, extending over several years. But his writings always commanded attention among a wide circle of readers beyond his friends and professional acquaintances. In those writings lives the imprint of a forceful personality. Even in his foibles he was dynamic, never dull. A. W. ALLEN.

Right to left: Alfred James, J. S. MacArthur, G. Mason, F. Inglis, W. A. Caldecott, and W. Titmus; taken at the Salisbury demonstration plant in 1900

INDUSTRIAL PROGRESS

Gold Prospecting Facilitated by Light-Weight Core Drills

Lewed L. Jessen and Fred E. Lindhe
Boyle Bros., Salt Lake City and Vancouver, B. C.



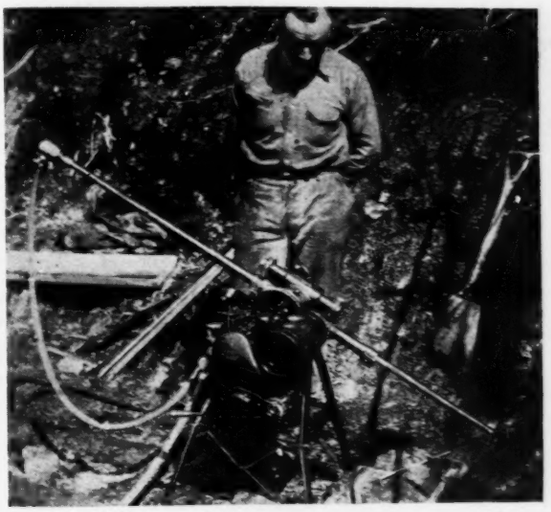
The "Baby" drill, mounted for a surface set-up. It is powered with an Austin engine

THOUGH prospecting, in popular conception, connotes the hardest sort of hard work, an opinion for which the historical record affords ample warrant, scarcely a single back-breaking and physically exhausting task now remains, in this sphere; for the ingenuity of inventor and technician, plus modern airplane transportation facilities, have made prospecting, when scientifically planned and competently directed, the practical equivalent, however rough the country, of a vacation or camping trip. Wherever he goes, the modern prospector takes with him the labor-, time-, and money-saving paraphernalia that modern science and technical genius have evolved to facilitate the discovery of metals and minerals.

We can speak with the authority of wide and long experience of the fascinating vocation of prospecting. We have packed drills into the Coast range of British Columbia as much as 20 miles, piece by piece, on men's backs. We have chopped out glacier ice for the platform and drilled through the ice to reach bedrock, and have leveled out desert sand in South America under a baking sun; have packed drilling outfits across the Andes by burrows and mules; and have had drills in Africa where animals were unable to live because of the tsetse fly. We have had a drilling machine set up on a scow on the coast with a piece of boiler plate bent into the shape of a propeller attached to a drill rod and turned by the machine on the scow when the drill crew turned into a boat crew. We have been out in the hills where a breakdown meant either lose your head or your leg, and on one occasion a piece of scrap iron plus a generous tough piece of bacon rind served to attach a connecting rod to the crankshaft of a gas engine. We have seen a diamond drill used as a pile driver to drive a platform on a lake where no pile driver was available. We have drilled on the main parapet of a great city—and so far away from civilization that it cost 50c. to send a letter home. We have drilled in the North in the barren country where the ground is perpetually frozen and where if one touches the drill rod with his naked hand, the skin sticks to the rod; and under tropic heat, where if one touches the drill rod with naked hand he gets severely burned and where the ground is so perpetually hot that the return water comes out of the hole hot. We have paid as high as $6 a day for helpers and as low as 12c. a day for the same work in South Africa, where the laborers also rustled for their own lodgings. These experiences are set down in no spirit of self-praise or glorification. They are offered solely to afford a sound background for our newest development in the field of the diamond drill.

A knowledge of the fundamentals of geology and skill in the use of geophysical methods may identify and discover the mineral treasures of the earth, but only exploration can prove them up, and until very recently exploration has necessitated the sinking of shafts, the boring of tunnels, and trenching to confirm or disprove the presence of mineralization indicated by surface phenomena and geophysical data.

The use of the diamond drill dates back sixty years or so, the boring of the 9½-mile St. Gothard tunnel in 1872 to 1880—among the distinguished engineering achievements of the nineteenth century—being one of its early and successful applications. Prospecting with this medium, however, is comparatively new, as is also the use of small power drills underground in narrow workings which could be made to accommodate the larger types of drill only by extensive and expensive en-



So-called "X-Ray" diamond drill. The total weight is 210 lb. including 50 ft. of drill rod. At this set-up, a 51-ft. hole was put down in two days.

largement of stopes, raises, and shafts to provide drilling stations.

That there may be some virtue in the application of the sweet uses of the adversity which the current industrial depression has inflicted on the world is proved by the fact that many individuals and corporations in the mining industries have utilized the slack period to marked advantage by devising newer, easier, and better ways of accomplishing routine prospecting and mining operations.

For several years prior to the beginning of the depression in 1929, so extensive were the activities in diamond drilling in practically every country of the world that it was almost impossible for the mining companies operating their own drills and equipment, and the diamond-drill contractors as well, to procure sufficient experienced operators to go around. The condition necessitated the breaking in and training of new operators by the score. When the depression struck, chaotic conditions, with curtailment of expenditures, ensued in many mining camps throughout the world, with the result that diamond drillers everywhere found themselves unemployed, and though many took it more or less philosophically and began drifting with the tide, the authors of this article, who have long been identified with Boyle Bros. Drilling Company, of Salt Lake City, Utah, and Vancouver, B. C., evolved a different conception of what the situation required. So, instead of waiting for prosperity to return, we concluded that the time was ripe to make improvements in diamond drills to reduce operating expense, particularly in view of the fact that economic management of mines became imperative for success. With this objective in mind we set out to make a light underground machine, the results of which have been that short-hole drilling has become preferred practice in many operating mines and the cost of drilling has been practically cut in half by this type of work, largely by reason of the elimination of the necessity of cutting drilling stations. In fact, the saving alone in this respect represents from fifty cents to one dollar per foot of drilling done. This, together with small air consumption, added drilling speed, and an internal lubricating reciprocating engine, plus cost of time through frequent overhauling, effected, obviously, a considerable saving. With the resumption of normal operations, many mines will take greater advantage of the small and easily portable diamond drill for underground exploration. Its function in subsurface mining is to explore into the walls of raises and stopes.

In addition to the Baby drill, for underground work, we arrived at the conclusion that something also ought to be done to enable the mining engineer and geologist to get below-surface samples when out on extensive reconnaissance

Left, L. L. Jessen, Right, F. E. Lindho

trips, particularly to determine whether leaching has taken place at the apex of an orebody, as well as to enable the prospector and miner to ascertain something about the value of their claims by a method other than trenching, tunneling, and shaft sinking. The result of our experimentation was a very small, "vest-pocket" type of drill which we have called the X-Ray. This little drill was taken to three of the largest mines in British Columbia for a test, and in each operation it was successful. It produces a $\frac{3}{4}$-in. core or sample of the rock penetrated, practically as large as the core made by larger drills.

The miniature drill is run by a 1-hp., single-cylinder air-cooled gasoline engine, with high-tension magneto in the flywheel. Its gas consumption is less than one standard gallon for each eight-hour shift. Its total weight is but 210 lb. including 50 ft. of drill rod in this weight. The drill is equipped with Timken roller and S.K.F. bearings and has two selective feeds, either of which can be made use of while the drill is in operation. The pump used is chain-driven and is equipped with a relief valve. It has a capacity of $2\frac{1}{2}$ gal. per minute at 100-lb. pressure. Drill rods for this unit are made of 1-in. seamless tubing, in 3-ft. lengths for convenience in packing and transportation. The capacity of the drill is 100 to 150 ft. At the Premier mine, in British Columbia, 51 ft. was drilled in one day, which included the packing of the drill, preparing the set-up, laying of water line, and moving out the device. The gasoline consumption was less than one cent per foot drilled, and as only one operator is required to run the machine, a material saving is effected, not to mention the time saved over antiquated methods of surface trenching or test pitting.

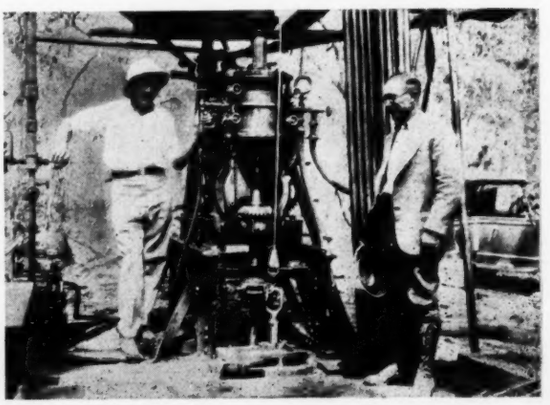
In addition to the X-Ray drill, Boyle Bros. have devised and placed upon the market a variety of sets of bits equipped with bort, and ready-set bits of carbon (black diamond).

In recent months the most insistent demand for diamond drillers and for industrial diamonds has come from the Soviet government of Russia, where many Americans and Canadians are now proving up metallic, non-metallic, and carboniferous areas. The greatest concentration of effort in diamond drilling in the next decade may consequently be expected in Russia, in whose vast domain the hum and hammer of mining machinery assures that country a conspicuous place and record in the mining regions of the world in the not distant future.

The prospector of tradition, bewhiskered and old, with his Jenny mule, bacon and beans, pick and shovel and pan, his hunches and his all-too-often visionary hopes, belongs to the vanishing past. As pursued in the modern manner, prospecting and investigating, locating and proving deposits, are the work of days instead of months, and may be conducted with ease and comfort, and with a minimum expenditure of time and money. Where roads have not yet penetrated, the airplane can within a few hours at most land a prospecting party, fully equipped; and it will call for the return trip at the appointed hour.

Much prospecting for gold will characterize the next few months in mining regions throughout the world, for gold is more valuable now than it has been at any other time in many decades. Modern prospectors, however, will not snoop and poke about among the rocks and tundra, trusting to luck and chance. The era for prospecting for outcrops is fast vanishing. The present and the coming generations of prospectors and mining engineers will bring to their use and service, in addition to geophysical and other scientific surface methods, a drill that can penetrate to 100 ft. or more, and thus approach nearer to the hidden secrets of the earth.

Within the next five years the modern engineer-prospector should, with the scientific and modern equipment at his



Working with a drill of ordinary size in Northern Rhodesia. Mr. Jessen at left.

command, discover and make available for development and exploration many gold-bearing areas without surface evidences of mineralization, the existence of which has been well concealed, but whose secrets may now be uncovered by science and modern machinery. And whatever the future may hold for industry and for nations, the market for gold is assured for all conceivable time.

Though existing conditions are trying, at this juncture of the world's affairs, to the peoples and the governments of the earth, youth and will, and a spirit of adventure, are still with us—and ever shall be. In them resides a sure reliance. They never yet have failed mankind, and will not. They triumphed with the old tools, the old devices. They can be trusted to venture and to attain even more greatly with the new.

■ ■

Distinct Advance Scored in Design of New Mine Fan

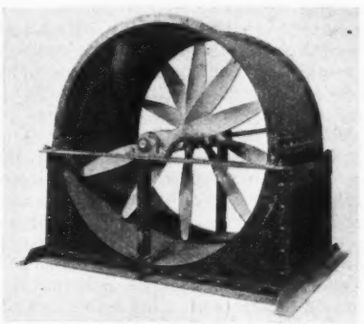


Fig. 1—Aerobladed fan installed at Montreal mine, Montreal, Wis.

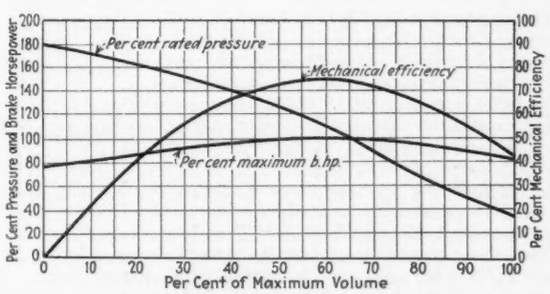
A MINE FAN having interesting features was installed during the last twelve months at the Montreal iron mine, on the Gogebic Range in northern Michigan, as described in an earlier article. It was an aerobladed fan and in construction was similar to the fan shown in Fig. 1. Five propellers are mounted on one shaft, an arrangement said to have been used abroad to a limited extent.

This fan was of Jeffrey make and has recently been materially improved by the company. Upon request, W. J. Montgomery, manager of the company's ventilation department at Canton, Ohio, has described the experiments made with it and their result in the production of a fan of modified design and improved characteristics. This newest fan has been named the "Aerovane."

In experimenting with the earlier aerobladed type, said Mr. Montgomery, the discovery was made that, although it was fairly effective and efficient, it had too great an area in the center which was not effective—that is, the rotative velocity of the blades near the shaft was slow, compared with that at the outer tips, and some tendency existed for air to reenter through the center. Experiments were made on this type of wheel, with the blades in different positions and at different pitches. The air foil section of this blade was found to be more effective than in the case of the ordinary disk type of fan.

The most effective portion of these propellers was therefore taken and mounted on a hub, all in the same plane, the resulting product being the new Aerovane type, shown in Fig. 2. Each blade of the older type fan, Fig. 1, runs in a plane of its own, but Fig. 2 shows all the propellers in the same plane. A cone casing was also designed for the wheel so that the air is gradually expanded when the fan is operating in either direction.

The new fan has distinct advantages over the ordinary disk type of wheel. It will produce at above 70 per cent mechanical efficiency when operating between 45 and 72 per cent of maximum volume, and will work against much higher pressures than the ordinary disk type of fan. It has a non-overloading characteristic, shown by the per cent maximum horsepower curve. In other words, if a motor is selected to operate the fan at any duty around its highest point of efficiency, no danger exists of overloading the motor, no matter what the mine conditions are. If the fan is underloaded in volume, the pressure rises and the horsepower drops off, and if it is overloaded in volume, the pressure drops and the horsepower again drops. This characteristic is quite different from that of the ordinary disk fan. With the latter, the more the duct system on which the fan is tested is restricted, the more the pressure rises, but the horsepower also rises, whereas with the Aerovane type the horsepower drops off.



Characteristic curves of improved fan

Mr. Montgomery believes the new fan is an advanced step in design and construction of propeller fans for use in mines and should replace many inefficient disk fans for the following reasons: The efficiency of the ordinary disk fan does not exceed 50 per cent and with the Aerovane fan an appreciable power saving is made. Also the ordinary disk fan will not develop over 1-in. gage and be efficient, whereas the Aerovane fan will work up to 2 in. and more, depending altogether on the speed, and will be just as efficient at this duty as when operating on ½-in. gage. The fan also would replace many old wooden-housed centrifugal types because it is a fireproof equipment, whereas the other type of fan is a source of danger. Moreover, many large centrifugal fans of steel construction are operating on duties for which they were not designed or specified. Where large volumes against high gages are not required, this type of fan could be substituted to advantage.

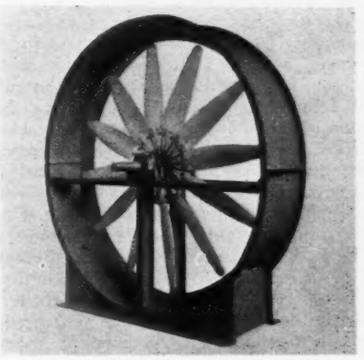


Fig. 2—Improved type with airplane propeller blades revolving in same plane

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Bulletins

Screens. Robins Conveying Belt Company, 15 Park Row, New York City. Bulletin No. 80, Gyrex screen.

Vibrating Screen. Allis-Chalmers Manufacturing Company, Milwaukee, Wis. Bulletin No. 1470-B, centrifugal vibrating screen.

Flotation. Ruth Company, Denver, Colo. Booklet entitled "Metallurgy of the Gradient Cell."

Grinding, Screening. Mining & Industrial Equipment Ltd., 11 Southampton Row, London, W.C. 1, England. A booklet.

Fire Brick. Denver Fire Clay Company, Denver, Colo. Bulletin No. 144, Longer fire-brick service with Latite or Hifire Bond high-temperature bonding mortars.

NEWS OF THE INDUSTRY

Ontario's Latest Gold Area Is Swayze, Near Sudbury

Interest is being shown in the new gold discovery in Swayze Township, about 20 miles from Gogama, on the Canadian National Railways, northwest of Sudbury, Ont. At present about 100 men are in the field, but operations are held up on account of severe storms. At least 300 claims have been staked to date.

The original discovery, known as the Kenty, was made by Jay and Jack Kenty, well-known Ontario prospectors. The principal vein has been opened up at two points, 2,300 ft. apart. Intervening ground has not yet been explored. Over the 100 ft. that has been stripped the vein is about 5 ft. wide and, in addition to free gold, carries molybdenite and tellurides. Three other veins, between 3 and 4 ft. wide and showing visible gold, have also been uncovered. The original syndicate has a total of fifteen claims and is owned 30 per cent by the Northern Canada Mining Corporation, the old Beaver Mines of Cobalt; 30 per cent by Brett-Trethewey; 30 per cent by Northland Prospectors; and 10 per cent by Kenty Brothers. The Ontario government has sent geologists into the field. According to reports the geology is favorable and similar to that of Kirkland Lake. The district is readily accessible from either the Canadian National or Canadian Pacific railway.

■

Ashley Signs Power Contract

The Ashley Gold Mines, in Bannockburn Township, Ont., controlled by the Mining Corporation, of Cobalt, has signed a contract with the Northern Canada Power Corporation for electric power. A start has already been made on the construction of the transmission line, expected to cost $150.000. About 200 men will be employed in cutting the right-of-way, that is scheduled to be completed early in January next. Development work on the 125 and 250 levels of the mine has been stopped while sinking is being continued to 500 ft. Another new vein has been found on the surface and has been uncovered for a distance of 200 ft. The width is about 12 in. It shows considerable free gold and tellurides.

■

Estimate Beattie Reserves

Ventures, Ltd., which controls the Beattie property, in Duparquet Township, Que., has made an estimate of tonnage and values as a result of an extensive diamond-drilling campaign on this deposit. Drilling has indicated a length of 1,158 ft. with an average width of 107.9 ft. Tonnage is estimated at 5,390,000 short tons of an average grade of $3.07. These estimates are based on two series of diamond-drill holes at depths of 125 and 500 ft. and do not include any estimate of possible ore in other zones now being drilled. Included in the above estimate is one section, 590 ft. long, with an average width of 114.4 ft., estimated to contain 3,634,000 tons averaging $3.42. The company hopes to be able to develop a large low-grade operation.

■

Canadian Gold Mines Not Hurt by Dominion Gold Export Ban

Gold mines in Canada will not lose through the embargo on gold exports from the Dominion, which went into effect on Oct. 19. Although they will be forced to dispose of their production in Canada, they will receive the equivalent of $20.67 in U. S. currency, per ounce of fine gold produced. The Royal Mint, at Ottawa, has been paying at this rate ever since Canadian exchange dropped in the middle of September. As a result, the Canadian mines are realizing nearly $23 per ounce in Canadian funds for their output.

According to the order-in-council made public by Prime Minister Bennett, no gold coin, gold bullion, or fine gold bars can be exported from the Dominion except under the authority of a license issued by the Minister of Finance. No such license shall be granted to other than a Canadian chartered bank. It will be noted that nothing is said about gold in ore and concentrate. Canadian mines, particularly those in British Columbia, which ship production to U. S. smelters for conversion into metal, will not be affected.

■

Stop Bodie Underground Work

At Bodie, Calif., Treadwell Yukon has suspended all underground operations and has cut its force from 125 men to 75. Later the force will be reduced to 35. Operations will be confined to milling the low-grade gold ores on the dump and probably the milling of the whole of Standard Hill. Since Sept. 1, 1929, when Treadwell Yukon came into Bodie, about 22,000 ft. of underground work has been performed without opening an orebody satisfactory to the management for continued operations underground.

The Hearst and Haggin interests, which control Homestake, are said to be negotiating to take over the pumping plant and other machinery installed at the Red Cloud shaft by Treadwell Yukon. George L. Barnett, who has been in charge of the underground work, when in Reno a few days ago failed to confirm or deny the rumor.

Pan-American Conference Votes Silver Inquiry

Without the votes of the delegates of the United States and Brazil, the Pan-American Commercial Conference, representing countries of North, Central and South America, on Oct. 10 adopted a resolution by the resolutions committee requesting the governments of those countries to "consider the desirability of submitting to a world conference the possibility of rehabilitating silver." This final action of the conference on the silver question was a revision of recommendations by one of its group conferences, sponsored by Mexico, proposing an international silver conference. This recommendation was in turn a revision of a proposal of Salvador for a world conference to consider the remonetization of silver. Francis White, Assistant Secretary of State, said the terms of the resolution were uncertain, which prompted the United States delegation not to vote.

The conference also adopted a resolution requesting these countries to adopt a monetary standard which will assure a circulating medium necessary to guarantee normal commercial operations. This was a substitute for a resolution proposed by Peru and adopted by a group conference for adoption by Pan-American countries of the gold standard or the gold exchange standard.

■

Want Uniform Mexican Tax

Contending that such action would greatly assist Chihuahua state silver mines, the Chihuahua state mining chamber has petitioned the federal chamber of deputies to modify the national mining tax law to permit graduated reductions of levies for extraction of silver by any method. The present law allows these benefits only for silver obtained by amalgamation, cyanidation, and lixiviation. In urging extension of tax reductions, which resulted from a presidential decree in 1920, to all processes, the petition remarks that present quotations may not be bettered during the next two or three years. The chamber declares that silver mining in Chihuahua has been handicapped because of a deficiency of electric power from the Conchos River.

■

Maltby Magnesite Plant Damaged

The calcining plant of the C. S. Maltby Magnesite Company, south of Livermore, Calif., was seriously damaged by fire on Oct. 3, 1931, and the wooden building covering the kilns was also destroyed. The company is one of the principal magnesite producers in California.

C.&H. Has Fifteen Years' Ore in Upper Conglomerate Area

Richness of Calumet & Hecla's conglomerate copper ore in pillars and backs of stopes in upper levels of its mine at Calumet, Mich., has enabled it to maintain a high yield per ton from the conglomerate department. The average last year was 48.69 lb. of copper per ton treated, the conglomerate branch producing nearly 41,000,000 lb. of copper. Ore from the heavy shaft pillars and backs will continue to be a sweetener for about fifteen years, as the process of mining the large remaining tonnage, from the bottom upward, is slow. Conglomerate ore being opened below the No. 81 level haulageway is not as rich as in upper levels, the copper being distributed through a greater area of lode. In the upper part of the mine the high-grade mineralization was continuous. Ground north of the Red Jacket shaft is somewhat better than that directly beneath what was the richest part of the conglomerate deposits.

Kearsarge lode ore in the Ahmeek area is averaging 26 to 27 lb. of copper per ton in yield. The lower-grade ores in other sections of the Kearsarge are not being mined, because of the low price of copper. Low-grade ores in the Osceola lode shafts also are being left until a substantial improvement occurs in the market. The comparatively high yield of the conglomerate and Kearsarge ores now being mined is enabling Calumet & Hecla to keep its losses as low as possible. Working only four days a week, with a reduced force, production is less than half of capacity.

The conglomerate tailing deposit in the Hecla and Tamarack sand banks will not be treated until a demand appears for larger production. The Calumet deposit is nearly exhausted, and the remaining tailing is not so rich as that already reclaimed, but it will remain a source of copper, cheaply produced, for seven to ten years, depending on rate of extraction. An average of nearly 11 lb. of copper per ton has been recovered, at a cost of less than 7c. per pound, since operations were started. More than 268,500,000 lb. of copper has been obtained from these "waste" sands.

Since Calumet & Hecla Consolidated added to its railway system, six years ago, by building a line from the Kearsarge lode branches to the Ahmeek mill, on Torch Lake, the saving in cost of copper-ore haulage has been over $1,000,000, or more than the cost of constructing and equipping the line. This saving has been made in spite of the fact that the tonnage handled has never approached that estimated when the railroad was planned.

■

Government Positions Open

The U. S. Civil Service Commission announces open competitive examinations for the positions of associate and assistant metallurgists. Applications must be on file with the commission at Washington, D. C., not later than Dec. 30, 1931. Vacancies in departmental and field services will be filled. Entrance salaries for associate metallurgist range from $3,200 to $3,800 a year and for assistant metallurgist from $2,600 to $3,200 a year. Full information may be obtained from the Secretary of the United States Civil Service Board of Examiners at the post office or customhouse in any city or from the United States Civil Service Commission, Washington, D. C.

■

G. G. Rice, on Trial, Continues to Act as Own Lawyer

George Graham Rice, whose mining-stock promotions put him in Atlanta Penitentiary two years ago for mail fraud, appeared in Federal Court in New York City again on Oct. 19 in the dual capacity of defendant and counsel to answer and attempt to refute the charge that he had evaded income taxes in 1925 on an income of $1,800,000. The promoter was his own attorney because, as he said, he was "too impoverished to retain one." A guard stood near as he outlined his defense to the jury. His sentence in Atlanta has not been completed, although he became eligible for parole earlier this year.

He won a point the following day when, acting as his own attorney, he was allowed to read into the record an affidavit, by Frank Silva, a former employee. It supported his contention that the income in question was not his but that of the Wall Street Iconoclast, Inc., the Idaho Copper Corporation and George Graham Rice Corporation, which he controlled, and was to the effect that Silva, in signing his name to stock contracts, had acted for the corporation and not for Rice. Silva, according to the testimony of Abner S. Werblin, broker, who testified for the government, acted as Rice's agent in the purchase of 1,900,000 shares of Idaho Corporation stock at a cost of $250,000.

Rice declared that he would call an array of prominent men as witnesses. Among those he mentioned were Joseph P. Tumulty, Max D. Steuer, William Travers Jerome, former Governor Charles S. Whitman, Daniel F. Cahalan, Jack Rothstone, administrator of the estate of Arnold Rothstein, and former Senator James A. Reed, of Missouri, once his counsel. These were a few of the 125 witnesses for whom he asked the court to provide traveling expenses. Judge Frederick H. Bryant reserved decision.

■

Silver King Western Reports

Silver King Western Mining & Milling, formed by stockholders of Silver King Coalition to develop ground adjoining the Coalition ground in the Park City district of Utah, has issued a report covering operations up to Sept. 30, 1931. Work was started on Nov. 6, 1930, through the Silver King Coalition tunnel. In the period since then, 2,043 ft. of 8x8-ft. drift has been completed. Eight ore-bearing fissure veins have been cut, containing silver, lead, copper, and some gold. No effort has been made to determine the extent or value of these fissures, the primary object being to explore as much of the ore-bearing zone at as early a date as possible. The company has installed its own compressor plant and equipment. An offer of 100,000 shares of stock at 50c. a share is made to stockholders to finance development.

Gold Fields Rhodesian Reports Debit Balance for Year

London, Oct. 21. — Gold Fields Rhodesian Development, which holds interests in several of the large Rhodesian gold properties, reports a profit of £7,181 for the year ended May 31, 1931, compared with £116,659 in the previous fiscal year. After writing off loans and investments the year shows a debit balance of £72,833, contrasted with the £78,965 balance of the previous year. The Mayfair Gold Mining property, in the Insiza district, of Southern Rhodesia, has been closed down, and the company is being placed in liquidation. Gold Fields Rhodesian controlled this mine, which started production in 1929 but which did not prove a profitable venture.

. . . . Results obtained by Victoria Prospecting, which had a concession of 9,000 square miles in Southern Rhodesia, have been negative. Gold Fields Rhodesia is also interested in this company. Efforts to secure a new concession in another district, which the Rhodesian is also interested in this comunsuccessful because of the opposition of the small miners, who felt that the large companies were being given too many privileges.

. . . . Sir Cecil Rodwell, governor of Southern Rhodesia, speaking before the Royal Empire Society, stated that 75 per cent of the colony's output is produced by ten mines and that it is showing an alarming tendency to decrease. He stated that discovery of two or three large new mines was necessary to maintain the prosperity of the industry and colony.

. . . . At the annual meeting of El Oro Mining & Railway on Oct. 16, J. H. M. Shaw, chairman of the board, stated that despite the drop in the average New York price of silver from 43.2c. an ounce to 29.7c. during the company's fiscal year, cash resources enabled the directors to declare a 7d. dividend on the stock, which has a par value of 5s. He explained the slight drop in ore reserves at the Noria mine, Sombrerete, Zacatecas Mexico [see p. 379 for further details of company's report] as resulting from the concentration of development work below the 266-m. level. No ore can be added to reserves from this territory until the 316-m. level has been further opened up. Since publication of the report, word has been received from the mine that the drift has encountered a fissure-faulted zone in the vein, assaying 750 grams of silver over a length of 18 m. and a width of 3 m. The face now shows 500 grams of silver.

■

McLeod River Dredge Progress

Two carloads of power-plant equipent have been shipped from Edmonton, Alberta, Canada, to Peers, consigned to McLeod River Mining, which holds placer gold deposits along the McLeod River. Construction work on the company's dredge is reported to have made rapid progress recently. This enterprise will be one of the first Canadian alluvial producers outside Yukon and British Columbia.

San Francisco Mines Plans to Close at End of 1931

San Francisco Mines of Mexico, one of the largest lead-zinc producers in Mexico, will suspend production at its property at San Francisco del Oro, Chihuahua, at the end of 1931, according to an announcement just made by the company. In the year ended Sept. 30, 1931, this company produced 393,390 tons of ore. Smelter receipts for concentrate were $1,531,368 and expenses were $1,503,183, leaving an indicated operating profit of $28,185. In recent months, heavy losses have been incurred, and September shows a loss of $48,385.

The San Francisco mine has been increasing its production in recent years as the result of favorable development results. In 1930, the company announced its intention of increasing mill capacity from 300,000 to 500,000 tons annually and of developing the Clarines deposit. The drop in metal prices caused a suspension of the Clarines program and restricted the mill enlargement to a 400,000-ton total. Recent months show a production of 3,800 tons of lead concentrate and 3,500 tons of zinc concentrate. The latter product is shipped to Belgium, but the lead concentrate is smelted locally. Metal is disposed of in the London market, and the recent change in sterling has affected the company. It is controlled by Union Corporation.

Arrangements have been made to keep the mine and plant in order so that operations may be resumed as soon as conditions permit.

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Wade and Hobbins Elected to Silver Producers' Board

Directors of the American Silver Producers' Association were reelected at the annual meeting held in Salt Lake City, Utah, on Oct. 12. W. R. Wade, of Park City Consolidated, and J. R. Hobbins, of Anaconda Copper, were added to the board to fill vacancies. Delegates recommended that W. Mont Ferry be reelected president of the association at the annual board meeting, in November. The meeting also favored the holding of an international silver conference as the only solution of the silver question. Senators Borah, King, Oddie, Pittman, Smoot, Swanson, and Walsh were commended for their work on behalf of silver.

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Siskiyou County Gold Activities

A sampling crew is at work at the King Solomon gold property on Mathews Creek, Siskiyou County, Calif. Other prospects and small properties in Siskiyou are also active. These include the Cleaver at Whites Gulch, the Keaton, the Black Bear, recently acquired by the Black Bear Mining; the Victory, the Homestake, the Hogar, the Johnson, and other small properties. The Hickox placer property on the Klamath River near the mouth of the Salmon River has been bonded and preparations are being made for working.

BRIEF NOTES

Anaconda Opens Phosphate Mine. Operations have been resumed at the phosphate property of Anaconda Copper, at Conda, Idaho. About 300 men are employed. The product is used in connection with the company's sulphuric acid output for the manufacture of fertilizer. The property is the only large phosphate producer in Idaho at present.

Bagdad in Receiver's Hands. An Associated Press dispatch under date of Oct. 14 states that the Bagdad mine, in San Bernardino County, Calif., is in the hands of a temporary receiver as the result of action brought by Mrs. Ruth Graves, a stockholder. The present operating company is Bagdad Consolidated Mining. Past production is estimated at $7,000,000 in gold, copper, and silver.

Boriana Mill Closed. After shipping a carload of high-grade tungsten concentrate from its new flotation plant, near Yucca, Ariz., Boriana Mining has suspended operations. The suspension is the result of low prices for tungsten. The property is controlled by the Stoody Company. Copper concentrate, which was recovered in the course of operations, has been stored at the plant.

Cam & Motor Reserves Unchanged. Ore reserves at the Cam & Motor Gold mine, near Gatooma, Southern Rhodesia, were 878,000 long tons averaging 48s. 1d. in gold per ton on June 30, 1931, compared with 875,400 tons averaging 50s. 9d. at the end of the previous fiscal year. The company is Rhodesia's largest gold producer, having treated 292,000 tons for a recovery of £540,219 in gold during its fiscal year. Development results, on the whole, were satisfactory. On the No. 23 level of the Motor lode, the lowest workings in the mine, rich ore has been cut. The No. 21 level shows 240 ft. of ore in the Cam lode and 210 ft. in the Petrol lode. A drop in the antimony content of Motor-lode ore has resulted in suspension of smelting of antimony concentrate. It has been replaced by slime-table concentration and subsequent roasting.

Castle Peak Furnace Down. Because of water shortage, the Gould rotary furnace at the Castle Peak quicksilver property, 6 miles north of Virginia City, Nev., has suspended operations. However, 14 men are being kept on development. In the quarter ended Sept. 30 production was 239 flasks of quicksilver at a cost of $49.45 a flask. Ore yielded 11 lb. of quicksilver a ton, or about one-seventh of a flask. Total production for 1931 has been 618 flasks.

Comstock Cuts New Ore. A newly discovered oreshoot is under development from the third winze level at the Crown Point mine of Comstock Tunnel & Drainage, at Gold Hill, on the Comstock Lode, south of Virginia City, Nev. The south development drive, about 100 ft. south of the Crown Point winze, was reported a few days ago to show a full face of ore averaging 0.7 oz. of gold and 20 to 25 oz. of silver per ton, or about $20 a ton, of which two-thirds was in gold. Previous development had shown ore on all three winze levels north of the winze.

Dawes Gold Exploration. Drifting south of the new shaft on the 180 level of the Dawes Gold property, at Scossa, Nev., struck 5 ft. of ore on Oct. 17. Of this, 20 in. is said to be the best grade yet developed in the district. This property includes the ground on which the original Scossa discovery was made last year. E. M. Dawes, president of the company, has made the first payment on the Keough ground, which comprises two 40-acre sections adjoining Dawes Gold on the south. Recently, three Eastern stockholders of the company, accompanied by an engineer, inspected the property.

Diamond City Organized. Diamond City Mines has been organized by Robert Neilson, Frank N. Ellis, I. N. Foster, and T. S. Waltemeyer, of Seattle, and M. A. Ellis, of Townsend, Mont. The company has taken over 11 placer claims in the vicinity of Diamond City, Confederate Gulch, Mont., which produced considerable placer gold. It is planned to install hydraulic equipment.

Golconda Position Reviewed. In calling a meeting of stockholders of Golconda Lead, to consider increasing the company's capitalization, W. A. Beaudry, general manager, states that east of the fault on the 1,400 level ore has been developed for 350 ft. [latest report 375 ft.], making a total of 1,250 ft. of ore on this level. A raise is being put up in this ore to the 1,000 level, which has not been explored east of the fault. In addition, development of high-grade ore on Mayflower ground, controlled by the company, has enabled leaders to ship direct to the smelter. The meeting will be held Nov. 10.

I. B. Mining Activities. I. B. Mining, operating at Bannack, Mont., is now cyaniding about 50 short tons of gold ore per day, according to I. B. Haviland, general manager. The company has opened up a fair sized body of gold ore in the old Thompson tunnel and is crosscutting on the 300 level of the Excelsior to tap an orebody, which should be opened within 100 ft. It is also drift mining into placer ground which underlies the town of Bannack, under the direction of Frank Hancock, general superintendent.

International Opening Mercur Mine. Under the direction of D. C. Gilbert, 1,000 ft. of tunnel has been cleaned out at the Sacramento Gold & Quicksilver property, Mercur, Utah, which is being reopened by International Smelting. The mine was a substantial producer about thirty years ago. International plans an intensive campaign to open new bodies of gold and cinnabar ore.

Jack Pot Equipping. At the Jack Pot gold property, near Chloride, Ariz., equipment is being installed to expedite development work, reported to have opened a new 12-ft. vein. Until recently, drilling has been done with single jack and hand steel. Now a hoist, compressor, pump, and air drills are being put in. H. E. Robinson is in charge of operations.

Lehi Tintic Management. As the result of a suit tried before Judge T. D. Johnson, of the Utah district federal court, E. R. Woolley is returning 1,000,000 shares of Lehi Tintic stock to

the company's treasury and is resigning the presidency of the company, which holds ground in the Tintic district. E. W. Kelley is the new president of the company. Other new officers include Ralph A. Badger, secretary; and George Cannon and George H. Short, directors.

New Quincy Cuts Ore. New Quincy Mining has struck a new orebody in a winze below the 700 level in the Park City formation at its Little Bell property, Park City, Utah. The grade, where cut, is said to be about 33 per cent lead. A shipment of ore was made from the strike in the middle of October. This ore is in a fissure south of any previously productive territory in the company's holdings. The company had not shipped any ore for some time previously.

Silver Summit Absorbs Nellie. Silver Summit has taken a lease and option on the Nellie property, adjoining its own ground in the Coeur d'Alene district, Idaho. The main Silver Summit tunnel traverses Nellie ground and has cut the Nellie vein 2,200 ft. from its portal and 350 ft. below the No. 5 Nellie tunnel. As development below the No. 5 tunnel had shown silver-lead ore, drifting east of the Silver Summit tunnel along the vein is expected to open its downward continuation. W. J. Stratton, a Silver Summit backer, states that a 300-ton custom mill may be built to treat ore from the two properties.

Smuggler Sells Ramal. Smuggler Mining has sold its Ramal mine, near Placerville, Calif., to E. A. Montgomery and Littleton Price in return for a 20 per cent interest in a new operating company. Smuggler will not be required to aid in financing the property, on which development has indicated a gold orebody. A four-year option on the Franklin Hill channel property, 16 miles from La Porte, Calif., has been taken by the Smuggler company. Development will be under the direction of Robert Hammer, the present owner, and T. C. Cunningham.

Treadwell Closes Tybo. Operations at its Tybo zinc-lead unit, in southern Nevada, were suspended by Treadwell Yukon on Oct. 16. A small force of men will be retained to keep the mine unwatered and to do some development work. A 250-ton mill was put into operation at Tybo in 1929. Output in September is reported to have been 700 tons of lead concentrate and 650 tons of zinc concentrate. Production will be resumed when metal prices improve.

Walker to Continue. Production of copper concentrate at the Walker Mining property, near Spring Garden, Calif., will be continued despite low price of copper, directors of the company have decided. According to J. R. Walker, president of the company, the North orebody has been cut in three places on the No. 9 level and shows widths of 37, 75, and 100 ft., with assays of 3 to 4 per cent copper and $4 a ton in gold. Work is now being done on the No. 10 level.

Wallberg Puts in Hoist. An underground hoist is being installed by Wallberg Mining at its gold property, near Challenge, Yuba County, Calif. The company plans to sink a new winze on the orebody. A ten-stamp mill has been installed.

Wright-Hargreaves' New Vein.—The new vein recently found on the lower levels of the Wright-Hargreaves mine, at Kirkland Lake, Ont., is now being developed on four levels from 2,550 down to 3,000 ft. The average width is about 5 ft. and the average grade is better than the mine average of $12. Conditions at the mine have been further improved by the recent discovery of ore in the north vein, west of the Lake Shore fault on the 1,125 and 1,375 levels. About 100 ft. of drifting has been done on both levels, and the grade is well above the mine average.

Yellow Bulle Ships Gold. A bar of gold bullion, weighing 1,093 oz., has been shipped by the Yellow Bulle mine, at New Pass, between Fallon and Austin, Nev. The mine is one of the oldest in the state, and its first shipment of bullion was made in 1864. Recently it was taken over by new interests and reopened. The bar referred to is the product of two months of operation, under the direction of Wayne Smith.

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Rhokana Plant 75 Per Cent Done; Roan on Sterling

London, Oct. 20.—Estimates place the amount of work remaining to be done to complete the Rhokana mill and smelter at its N'Kana mine, in Northern Rhodesia, at about 25 per cent of the total. The plant, which will handle sulphide ores from the N'Kana mine and mixed oxide-sulphide ores from the N'Changa and N'Changa West deposits, will have a capacity of 7,000 tons daily. Early schedules had placed the date on which production would start at the beginning of 1932. A. D. Wilkinson, formerly of the Greene Cananea smelter, in Mexico, and now consultant on Rhokana's metallurgical work, is en route for his second visit to the N'Kana smelter.

. . . . Some confusion has been caused in Northern Rhodesia by the depreciation in the value of the pound sterling, and for a time the colony was not on the same monetary basis as Great Britain. This has now been adjusted, however, and announcement is made that Roan Antelope, the only important producer at present, is not only selling its copper for sterling prices but is also paying expenses in sterling. In other words, since depreciation in sterling has caused an advance (relative only) in the London price of copper, Roan has been able to cut its production expenses.

. . . . Trepca Mines, Yugoslavian lead-zinc producer, has declared an initial dividend of 5 per cent on the profits realized in the year ended Sept. 30. The company's capitalization is 4,400,000 shares of 5s. par, the dividend, therefore, being £56,000 on £1,120,000. Production started only in August, 1930, but has been at close to capacity since. In the fiscal year, the output was 41,358 metric tons of lead concentrate assaying 75.6 per cent lead and 27.95 oz. of silver per ton, and 31,769 tons of zinc concentrate, assaying 50.3 per cent zinc. Ore treated totaled 256,549 tons.

La Noria Starts Development on New Level at 316 M.

Exploration of the San Pedro orebody at the La Noria mine, near Sombrerete, Zacatecas, Mexico, is being undertaken on the 316-m. level, according to a report by El Oro Mining & Railway, which controls the property, a large silver producer. This orebody has been opened east of the shaft on the 236- and 266-m. levels. Development at the new depth is being undertaken through a winze sunk from the 266-m. level at a point 135 m. east of the shaft and at an angle of 50 deg. Pumping and loading equipment has been installed. Should satisfactory results be obtained, sinking to the 366-m. level will follow.

On the 266-m. level, the San Pedro ore is not so consistent as in the level above. During the year the east drift was continued 245 m. to a point 431 m. east of the shaft. It showed 131 m. averaging 724 grams in silver per ton over drift width. The remainder of the distance was low grade. Two winzes have been put down in the higher grade sections, but the water flow hampered this work. As soon as the 316-m. level pumping unit is in normal operation, this difficulty should disappear. Some encouraging results have been obtained in work already done on the 77- and 176-m. levels.

Ore reserves on June 30, 1931, were virtually unchanged from those at the end of the previous fiscal year, though the grade was lower because the company has been mining higher-grade ore to counterbalance the low silver prices. The estimate shows 201,011 metric tons, averaging 567 grams in silver per ton, available. Production in the fiscal year was 172,124 tons, from which 6,296 tons of concentrate, assaying 15,072 grams of silver and 15 grams of gold per ton, was recovered. In addition, 31.5 tons of high-grade was shipped direct to smelter. Working costs were reduced from $6.71 to $5.08 per ton of ore and at the end of the year were down to $4.31 per ton milled.

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Stop Sunnyside Tunnel Work

Failure to agree over the terms of a contract for driving the new 10,000-ft. transportation and drainage tunnel at the Sunnyside zinc-lead mine, controlled by U. S. Smelting, Refining & Mining, has resulted in an indefinite suspension of all work. Production from the mine was suspended last winter, because of low metal prices. The new tunnel will cut the orebody at a considerable depth below the present workings and will, when completed, replace the present cable-tramway system of transportation of ore to the mill. Work on the project was started this spring, about 45 men being employed. Construction of the surface plant and installation of equipment had been completed and a start made on the actual driving of the tunnel when the suspension occurred early in October. At first it was hoped that a resumption would be possible, but on Oct. 12 definite decision was made that the work would not be resumed. The workers desired to be paid on a daily wage basis, instead of the contract basis offered by the company.

Ship High-Grade Ore From Gold Mine Near Miami

Some high-grade gold ore is being shipped from the Moran and Slotkey mine, a small gold property at Radium, near Miami, Ariz. The vein that is being mined is 3 ft. wide, dips vertically, and strikes northeast and southeast. Near the north end line of the claims is a 48-ft. shaft on the vein, sunk by previous owners of the property. At the shaft bottom the vein contains a little gold and at the surface some ore has been mined. About 100 ft. southwest of the old shaft the present company has sunk another shaft to a depth of about 30 ft. Apparently the grade increases in a southwesterly direction from the new shaft. At present, 25 ft. from the shaft, ore is running better than 4 oz. in gold a ton.

The ore is hoisted in an 800-lb. bucket by a Fairbanks-Morse gasoline engine. A small mill has been built. It is equipped with a Huntington mill of 25 tons' capacity, made by the Walker Manufacturing Company, of Denver; three 3x4-ft. amalgamating plates; a Pierce amalgamator; and a Goulde centrifugal recovery pump. The mill, which recovers about 65 per cent of the gold, is not being operated at present, as the ore can be sorted and shipped to the smelter more profitably than it can be treated at the mine. Eight men are employed, and the output is about five tons per day. The company plans to sink the shaft to water level, which it expects to find at 125 ft. The company is not incorporated and is fully financed. Michael Moran is in charge of operations at the mine.

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Build New Gold Concentrator at Midnite Test Property

Construction of a new mill to supplant the 50-ton pilot unit that has been in operation at the property was started on Oct. 1 at the Midnite Test gold mine of National Exploration, near Prescott, Ariz. The pilot mill had been in operation for several months, and, according to W. W. Linesba, general manager of the company, an average recovery of 85.2 per cent was shown, using table concentration and flotation. All-over costs, including mining and milling, were about $6.20 a ton of ore. Ore and concentrate is shipped to smelter via Prescott, 11 miles distant, and the Santa Fe railroad. A highway connects the mine with the railroad.

The new plant is being built on the site of the old pilot mill, which affords gravity flow from shaft collar to concentrate bin. Ore bins are being enlarged to handle 300 tons. After passing through grizzlies, the ore goes to a Symons cone crusher, which will reduce it to ½-in. size. It will then be conveyed by apron feeder into a Marcy ball mill, where it will be reduced to about minus 30 mesh. The crushed ore will then be concentrated on four tables, each equipped with amalgam plates to catch free gold. Rejects from the tables will be dewatered and classified in a Dorr duplex classifier, which, in closed circuit with another ball mill, will produce a minus 200 mesh product.

The flotation section consists of one Ruth and one Fahrenwald machine. From these two machines the tailing will pass over a pilot table, to be used as a testing and experimental machine, before being thickened and stacked. About 85 per cent of the water used in the mill is expected to be recovered. Concentrate from the tables and the flotation units will be filtered in an Oliver unit before sacking for shipment.

At the mine, the shaft is being sunk 200 ft. below the present No. 4 level and two new levels will be opened up. The shaft is being sunk on the Midnite vein, at an incline of 80 deg. At present, ore is showing in the bottom of the shaft. In addition, on the upper levels, the vein will be crosscut to determine its width. From 50 to 60 men will be employed in this work. Mr. Linesba hopes to cut production costs to $4 a ton or less through enlarging the scale of operations.

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Compromise on Wage Scale to Keep Mansfeld Open

Heavy sacrifices by laborers, together with the ensuing subsidies from the rich Prussian state, have forestalled, for the time being at least, the threatened closing down to the Mansfeld copper mines at Eisleben, largest copper producers in Germany. Labor unions that had previously announced they had refused to accept more than a 7 per cent wage cut, against the 12 per cent demanded by the company, compromised at 10 per cent under a collective agreement, which runs to the end of March, 1932. This, according to the official statement, fulfilled the government's prescribed conditions.

In addition to the present annual subvention of 5,640,000 reichsmarks from the Reich and Prussia jointly, the Reich's Minister of Finance, Dietrich, will exercise the power granted under the most recent emergency decree and place a further 3,000,000 marks at the disposal of the company between now and the end of 1932. It is also reliably reported that the state of Prussia will advance a like sum covering the same period.

■

Unemployed Ask to Work Mines

Government financial and other aid in assisting them to establish and conduct cooperative societies to work mines and mining lands abandoned by the owners because of unprofitable exploitation has been asked of Gen. Plutarco Elias Calles, president of the Banco de Mexico, the Republic's 'central bank, and of the federal legislature, by Ireneo Contreras, representing unemployed miners in Chihuahua and Zacatecas, dismissed because of diminished operations by the mining companies.

■

Anaconda Reopens Fume Unit

Anaconda Copper has reopened its slag-fuming unit at East Helena, Mont. This unit recovers the zinc content of lead slag from the East Helena smelter of American Smelting & Refining and had been closed at the same time as the smelter.

Government Makes New Terms for Leasing Salduro Area

New terms have been arranged for lessees and permittees holding permits on the Salduro deposit, in Great Salt Lake, near Salt Lake City, according to an announcement by E. F. Taylor, register of the land office. For several years, Joseph L. Silsbee has carried on negotiations for the purpose of securing a lease from the government which would permit operations.

A minimum investment of $125,000 over a period of three years is required by the new lease. Production must be at least $50,000 worth of potassium and allied products from each of the five leases each year. Rental will be 25c. an acre the first year, 50c. an acre the next four years, and $1 an acre from the sixth year on. The leases each contain 2,560 acres. In addition, a royalty of 2 per cent of gross output of potassium and sodium salt will be imposed.

During the World War, the Utah Salduro Company spent between $2,000,000 and $3,000,000 in an attempt to work the deposits, but was forced to shut down when efforts to obtain a tariff failed.

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Oceanic Production Up

Production of quicksilver at the Oceanic mine of Consolidated Metals, on Santa Rosa Creek, San Luis Obispo County, Calif., was 11,932 lb., or 157 flasks, in September, and is expected to the 170 flasks in October, according to H. W. Klipstein, Jr., president of the company. Based on this rate of production, the mine has seven years' supply of ore in sight, he states. In 1930, production averaged 84 flasks monthly. Despite present low price of quicksilver, the operation is earning a profit sufficiently large to finance work at the company's Bishop Creek gold mine, where between 70,000 and 100,000 short tons of ore averaging $12 a ton is estimated to be in sight. The company's financial position has been improved in the last few months and now shows current assets of $143,456, compared with current liabilities of $10,489.

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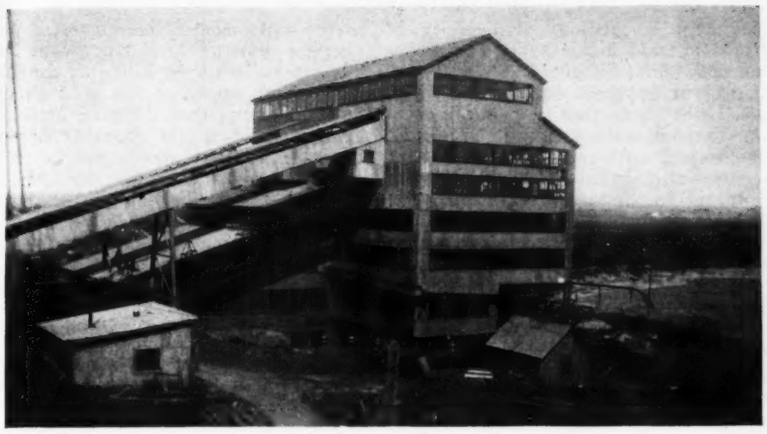
Texas Graphite Mine to Open

Plans for the purchase of the graphite mine and refining plant near Burnet, Tex., formerly operated by Southwestern Graphite, but now owned by Tennessee Coal & Iron Company, are practically complete. The new corporation being formed for the purpose will be composed of several Texas business men, headed by John W. Carpenter, of Dallas, president of the Texas Power & Light Company. Tennessee Coal & Iron Company has also taken stock in the new corporation. The graphite refining plant was recently appraised by engineers at $407,000. Southwestern Graphite Company ceased operations about two years ago, owing to the low price of the mineral. Its new refining plant, constructed at a cost of $500,000. had been finished but a short time when the company met with financial difficulties.



Hawkins plant of Wisconsin Steel

Adapt Mesabi Washing Units to Individual Ores

During 1931, concentrating practice on the Mesabi Range, great iron-ore producer in Minnesota, has been improved considerably as a result of the realization by operators that each ore deposit requires an individual flowsheet, instead of the standardized unit that had been used previously. Most of the companies now employ a research engineer and crew to run screen tests as well as jigging, flotation, and table experiments. Some of the recent changes are outlined in the following paragraphs.

At its Trout Lake plant, Coleraine, Oliver Iron Mining has installed an Allis-Chalmers Newhouse crusher and rolls with belt conveyors, bucket elevator, and vibrating screen to reduce the oversize from a maximum of 6 in. to a minimum of ¾ in. This equipment was installed last winter and was ready for the 1931 season.

At Taconite, the Holman-Cliffs washing plant carried on most of the Cleveland-Cliffs Iron research work. In a temporary addition built at this unit, the Hydrotator Company, of Hazleton, Pa., installed one of its commercial-size machines sufficiently large to handle overflow from a 25-ft. log. Comparisons were made between this machine and the Dorr bowl classifier installed when the plant was built. Other equipment on which tests were run included a Dorr-Fahrenwald sizer of six spigots, having a capacity of 10 to 15 tons per hour, classifying to a minus 8 mesh with a small-size Deister concentrating table following the Fahrenwald machine. A laboratory-size six-cell flotation unit built by the Denver Equipment Company is also installed at this plant.

At its Hawkins washing plant, Wisconsin Steel has installed jigging equipment, including two 6x12-ft. all-steel Hancock jigs, made by Allis-Chalmers. To prepare the ore for jigs, a 4-ft. oil-adjusted re-crusher and a set of 16x30-in. rolls, all furnished by Allis-Chalmers, are used. Oversize (about 2½ to 4½ in.) material is carried on belt conveyor from the large conical revolving screen in the regular flowsheet of the plant to the new crusher, which reduces it to 1 in. and discharges it to a Robbins vibrating screen, which separates the fines under ½ in. The rest of the material is passed through the rolls and reduced to ½ in. or smaller, as required, before being conveyed by belt to a storage bin, from which a steady feed for the jigs is secured by pan conveyor. Overflow from the jigs is piped back to a Dorr bowl classifier used in the old flowsheet and the fines are recovered through this machine.

At Nashwauk, Butler Brothers is operating McClanahan-Stone jigs in connection with the Harrison washing plant. Most of the company's research work is being carried on at the Madrid washing plant, on the Cuyuna Range, where a commercial-size flotation unit is available, the only one in the iron-ore country.

Pickands Mather has done most of its research work in recent years at the Danube washing plant at Bovey. This mine has been closed for the season. The screen and jig testing equipment was transferred to the University Experiment Station at Minneapolis.

At the Hill Annex mine, at Calumet, Interstate Iron carries on its experimental work. This year a structural steel screening plant, using Link-Belt moving grizzly bars and pan conveyor feed machines, was built, similar to the layout at the Mesabi Chief mine but having a greater capacity. The M. A. Hanna Company also contributed its share to the research work at the Mesabi Chief concentrator. No additional machinery was installed, but improvements were made in the equipment now in use.

Some of the fee interests are installing laboratories separate from the mine. The Great Northern Iron Ore Property office, at Hibbing, is equipped to run screen tests. The State Mineral Lands office, also at Hibbing, has a small laboratory in connection with its engineering department.

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Upton Acquires Oro Grande

G. B. Upton, pioneer mining man of the Wickenburg district, has again obtained full control of the Oro Grande property of 200 acres, near the Hassayampa River, at Wickenburg, Ariz. The holdings were transferred from P. M. Shelby and associates, of El Paso. The mine has extensive development, including a main working shaft, 340 ft. deep. It is equipped with a ten-stamp pilot mill, erected for testing reduction processes. Mr. Upton will sink a new shaft in the hope of developing enough ore to warrant erection of a modern large-scale milling plant. An estimate has been made that 635,000 short tons of $5 gold ore is available for extraction. Diamond drilling operations have been carried to depth of 625 ft.

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Wages Cut Again at Mohawk

Mohawk Mining, Michigan copper producer, has further reduced wages, effective Oct. 10, 10 to 15 per cent. To take care of men who were employed in No. 1 shaft, now closed, a new working schedule has been adopted for No. 6 shaft, the only operating unit. The shaft will continue to work six days a week, but shorter shifts have been established. The men employed underground will be five, seven, or nine shifts short per month, depending on the nature of their work, under the new arrangement.

■

International on Part-Time Basis

The International smelting plant, at Inspiration, Ariz., is now being operated on a half-time basis. It is run seven days a week for two weeks, and the furnace fires are then banked for the succeeding two weeks.

Hydrotator unit at Holman-Cliffs' Taconite plant

Trust Laws, Geology, Silver Discussed at Joplin

Lambasting of the Sherman anti-trust laws, revival of the unsolved geological controversy between the descending and ascending theorists on the deposition of the Joplin zinc-lead orebodies, and discussion of monetary systems in relation to silver, occupied the attention of the visitors to Joplin and the Tri-State district for the joint meeting of the Western division of the American Mining Congress and the regional meeting of the A.I.M.E. The convention was officially dated for Sept. 28, 29, and 30, but was unofficially opened with a conference of the engineering education committee of the Institute on Sept. 27, in the Gold Room of the Connor Hotel, the convention headquarters.

Leading educators in the engineering field, including Thomas T. Read, Columbia University; M. F. Coolbaugh, Colorado School of Mines; Francis A. Thomson, Montana School of Mines; Dorsey A. Lyon, University of Utah; and others, went on record as favoring the continuation of the Institute's educational work by approving a motion authorizing the appointment of a committee to make a thorough study of the question and report at the next annual meeting of the Institute. Charles H. Fulton, of the Missouri School of Mines and Metallurgy at Rolla, Mo., presided at the meeting.

The closing day was set aside for a tour of the mining field. At Miami, a sister city of the Tri-State district, the members were served a barbecue luncheon, followed by a rodeo presented by the Baxter Springs and Miami troops of the Boy Scouts of America. The field trip was resumed in the afternoon and ended at the Joplin headquarters.

Interspersed in the convention was an elaborate entertainment program that aided in brushing away the rather melancholy thoughts engendered by the dissertations on the problems facing the mining industry. Included in the program was a special feature for the women visitors.

The depression cut into the attendance at the gathering, but, even so, more than 300 persons registered during the convention, with a sizable majority registering from the Tri-State district.

The convention was officially opened on Monday morning by Robert E. Tally, vice-president of United Verde Copper, president of the Institute and a former president of the congress. He introduced A. Scott Thompson, of Miami, who welcomed the guests to the district. Then H. Foster Bain was introduced, and he responded to the welcome in behalf of the Institute, and James F. Callbreath, who responded for the congress and who reminded the delegates of some of the incidents that took place at the American Mining Congress meeting held in Joplin 24 years ago.

With the preliminaries over, J. C. Heilman, of Baxter Springs, discussed "Mining and Economic Conditions in the Tri-State District."

The mining industry is facing the mineral surpluses of the country in more or less of a daze, C. K. Leith, chairman, department of geology, University of Wisconsin, said in his paper on "Problems of Mineral Surplus." Great as are the present apparent surpluses of minerals, Leith stated that he believed them none too adequate for national safety, when viewed with respect to the future. Increased conservation laws, he thought, might aid the industry in keeping the surplus minerals off the markets until needed. Reduction of taxes on mining lands inactive might aid in keeping some of the minerals in the ground until needed, he thought.

Mr. Leith presided at the Monday afternoon session, which brought out an attendance that taxed the capacity of the Empire Room of the Connor. George M. Fowler and Joseph P. Lyden, geologist, Joplin (following the reading of a paper on "Occurrence of Lead-Zinc Ores in the Dolomitic Limestones of Northern Mexico," prepared by M. W. Hayward and W. H. Triplett, geologist, Cia. Minera de Peñoles, Monterey, Mexico, and read by Secretary Bain), presented the ascending theory of deposition, which was followed by a presentation of the descending theory of deposition, by H. A. Buehler, Missouri state geologist. Buehler contended that no igneous minerals were found in the entire Ozark region and that all the orebodies here were found within a few hundred feet of the surface, geologically speaking, and that no ores had ever been found in deep well drilling below this horizon, and for that reason he contended that the ores were from solutions descending.

Monday night an informal smoker was held for the guests atop the Connor. The roof garden was turned into an old Western scene, with a bar and free lunch and gambling tables of all descriptions. Each guest was given a bundle of paper bills to play the games of chance. Later in the evening an orchestra and a number of vaudeville acts were presented.

Henry M. Payne, consulting engineer for the congress, presided at the Tuesday morning session, at which the problems of the Western mining industry were discussed in papers presented by Congressman Joseph J. Manlove, Fifteenth district of Missouri, ranking member of the House of Representatives Committee on Mines and Mining; James F. Callbreath, on "Problems Facing Mineral Producers"; and President Tally on "Regulating Mineral Production to Meet Demand." All the speakers advised some sort of revision of the anti-trust laws so that the mining industry could regulate its affairs.

Silver and taxation were the topics under discussion at the Tuesday afternoon session, presided over by Victor Rakowsky. W. Mont Ferry, of Silver King Coalition Mines, and president of the Silver Producers' Association, in a paper on "The World Silver Situation," advocated the calling of a world-wide conference on silver by President Hoover, at which the best minds of America should be included and at which some plans for the rehabilitation of silver should be formulated. The monetary system, he stated, is founded on too narrow a basis. Gold production, he said, has increased at the rate of about 1½ per cent per year, while commerce and business has increased on an average of from 3 to 5 per cent. The silver association, he said, had conducted a thorough study of the gold situation and had found that the gold production of the world would probably begin to decrease by 1934 and would be 20 per cent less than at present by 1945, and for that reason he thought that some thought should be given to silver in the monetary system.

A. W. Dickinson, chief of the tax division of the congress, discussed "National Revenue and Mining," followed by a paper on "Stabilizing Our National Resources," by Frank H. Probert, dean of the Department of Mines, University of California.

The annual banquet was held on Tuesday evening, at which the ladies were present, and which was followed by an informal dance. Charles A. Neal, president of the Tri-State Zinc and Lead Ore Producers' Association, was toastmaster at the banquet. Secretary Bain told briefly of his recent trip to Europe and was followed by Rev. Cliff Titus, a Missouri state senator, who brought a word of cheer to the visitors surfeited with "fears of the future" created at the business sessions.

During the field trip on Wednesday the visitors were taken underground at the Blue Grass mine of Commerce Mining & Royalty and the Shorthorn mine of Bilharz Mining in the morning. In the afternoon they visited the central power house and the Bird Dog mill of the Commerce company. Arrangements for the convention were made by C. F. Dike, Joplin, governor of the Western division; George Fowler, chairman of the Joplin-Miami section of the Institute; Charles A. Neal, president, and M. D. Harbaugh, secretary, of the Tri-State Zinc and Lead Ore Producers' Association.

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Locke Discusses Prospecting

On Oct. 13, the San Francisco section of the A.I.M.E. listened to W. W. Bradley, California State Mineralogist, discuss "Progress in Geological Mapping in California." F. G. Tickell, professor of petroleum engineering, Stanford University, reviewed the present position of geophysics in petroleum prospecting and described modern methods of correlation. Augustus Locke speaking of gold mining and the engineering side of ore finding, said that new methods of prospecting, based upon structural framework that can stand the test of ore hunting, are necessary.

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Smelters Lose Smoke Suit

Nick Kovacovich and his wife, Verde Valley farmers, have been awarded $5,000 damages in their smoke suit against the two Jerome copper smelters by a superior court jury at Prescott, Ariz. United Verde Copper must pay $3,000 of this amount because the smoke from its smelter contains a greater amount of sulphur dioxide than the smoke from the U.V.X. smelter. The U.V.X. company must pay the remaining $2,000, and the two companies must also pay a jury expense of $645.

MARKET AND FINANCIAL NEWS

Stocks of Refined Copper Increased 24,121 Tons

The increase in refined copper stocks in the hands of North and South American producers during September was larger than expected, the gain amounting to 24,121 tons, occasioned largely by another decrease in both foreign and domestic shipments. Blister stocks increased 2,320 tons, making a net gain in total stocks of 26,441 tons, according to the American Bureau of Metal Statistics.

Shipments fell to a new low, the total for September of 62,583 tons comparing with 74,832 tons in August and 103,042 tons in September last year.

Summary of Copper Statistics

In tons of 2,000 *lb.*

Production:	August	September
Mines, United States	38,925	38,088
Blister, North America (*a*)	62,237	61,183
Blister, South America (*a*)	23,334	23,020
Refined, No. and So. America	90,190	86,704
World, blister basis	121,655	120,689
Stocks (end of month):		
No. and So. America:		
Blister (*b*)	176,105	178,425
Refined	455,775	479,896
Totals	631,880	658,321
Great Britain (*c*)		
Refined	25,157	25,269
Other forms	1,344	1,595
Totals	26,501	26,864
Havre	10,709	13,300

(*a*) Includes direct-cathode copper. (*b*) Includes in process. (*c*) Official warehouses only.

U. S. Mine Production

	August	September
Porphyry mines	18,163	18,105
Lake mines	4,168	4,054
Vein mines	15,294	14,629
Custom ores	1,300	(*a*) 1,300
Total crude production	38,925	38,088
Daily rate	1,256	1,270

(*a*) Partly estimated.

Smelter Production

	August	September
United States	47,246	47,012
Canada	10,586	10,497
Mexico	4,405	3,674
South America	23,334	23,020
Totals	85,571	84,203

Shipments

North and South America

1930	Export	Domestic	Total
January	30,358	69,932	100,290
February	29,597	61,879	91,476
March	30,523	73,644	104,167
April	29,196	50,017	79,213
May	49,115	75,760	124,875
June	44,818	71,887	116,705
July	42,466	75,436	117,902
August	38,319	56,810	95,129
September	37,873	65,169	103,042
October	38,246	75,703	113,949
November	45,051	62,693	107,744
December	39,169	69,854	109,023
Total	454,731	808,784	1,263,515
1931			
January	45,597	60,209	105,806
February	39,415	60,636	100,051
March	36,797	74,685	111,482
April	32,218	54,567	86,785
May	26,684	45,265	71,949
June	33,251	50,217	83,468
July	26,321	43,144	69,465
August	29,016	45,816	74,832
September	22,124	40,459	62,583

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Kilo-Moto Gold Report

In 1930, Kilo-Moto Gold, leading gold producer of the Belgian Congo, made an operating profit of 36,190,983 Belgian fr. After deductions for depreciation and depletion, net profit was 19,431,267 fr., of which 15,555,555 fr. was paid out in dividends on common stock and 1,656,000 fr. in dividends on preferred stock. Total value of gold production of 4,597 kg. was 96,973,754 fr. During the year, the company reduced the preferred stock outstanding through the purchase of 1,200 shares at 500 fr.

A. S. & R. Earnings Down—Dividend Reduced

The American Smelting & Refining Company reports for the six months ended June 30 a consolidated net income of $1,265,173 after all charges and reserves, including taxes but before inventory adjustments. The company has written down to cost or market, whichever may be the lower, its metal stocks in excess of normal. This involved a charge against profits of $1,487,230, after giving effect to which the company failed to earn its preferred dividends by the amount of $1,084,826. The company announced that this is a book write-off and is not necessarily an actual loss.

Total current and miscellaneous assets amount to $76,991,219, more than 5.456 times total current and miscellaneous liabilities of $14,109,096. At the end of the first half of the year the company had on hand, in cash and U. S. government securities, $20,726,664.

The company declared a quarterly dividend of 37½c. a share on common stock, placing the stock on a $1.50 annual basis, against $2 previously.

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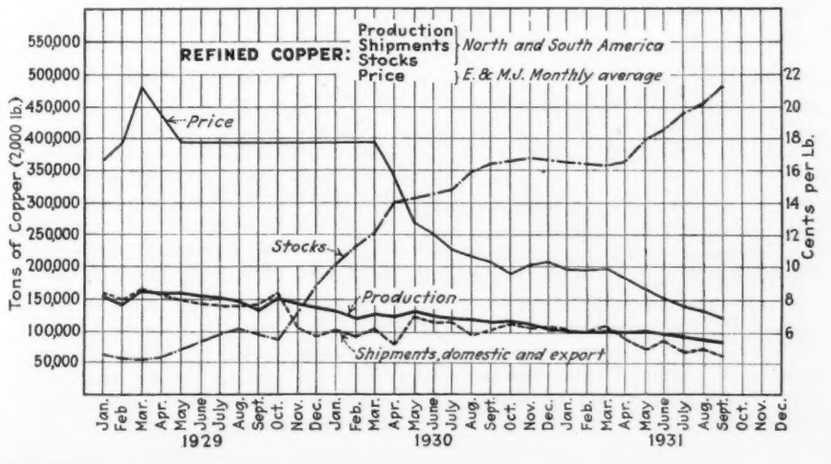
Ontario Record Gold Output

A new high production record for Ontario gold mines was established in September, according to the report of the Ontario Bureau of Mines. During the month a total of 425,164 tons was treated, the total value recovered, exclusive of exchange, being $3,850,282, an average of $9.07 a ton. This compares with a production of $3,618,000 in July, which was the highest monthly output up to that time. The increase in total production is to be credited to Porcupine, which produced $1,981,624. This is the first time for seven months that the Porcupine production has equaled or exceeded that of Kirkland Lake, which amounted to $1,781,573. Also, for the first time in several months the output of the Hollinger mine, in Porcupine, was greater than that of the Lake Shore Mine, in Kirkland Lake, the individual mines in order of gross output being Hollinger, Lake Shore, Teck-Hughes, McIntyre, Dome, Wright-Hargreaves, Howey, Sylvanite, Coniaurum, Kirkland Lake Gold, Vipond, March, Minto, Parkhill, and Munro-Croesus.



Monetary Change Affects London Trade in Zinc

INTERNATIONAL METAL SERVICE, LTD.
LONDON

The zinc market, as that of all other metals, has been overshadowed by the departure of Great Britain from the gold standard, and a heavy line can be drawn after Sept. 18, the last day on which quotations were on the old gold basis. Prior to that date, however, the market had been sagging under the general depression which overhung everything. Since the suspension of the gold standard the day-to-day price has varied in accordance with fluctuations in sterling exchange.

During the first fortnight after the monetary change, Continental smelters maintained the same selling price as existed just before Great Britain suspended the gold standard, though these European sellers have of course changed their bases of price and are quoting in various currencies still on the gold standard. The Giesche company, for instance, has adopted the United States dollar standard, being no doubt influenced by its Anaconda control.

In the main it must be admitted that September was a very poor month from the point of view of consumption, though in the latter days there was a very welcome increase in the flow of inquiries and also actual business coming to British galvanizers, and this industry at all events is apparently going to benefit from the monetary change. Naturally, prudence counsels waiting another month before attempting any definite view as to the ultimate outcome of the change.

As for other consuming outlets, it is difficult to get a clear view of just how the financial upset has affected them. In zinc sheets, for instance, it was almost impossible on some days for a buyer in England to get a quotation for Continental sheets; in one instance rates were given in United States dollars, which did not help matters at all. The main consideration is that any noticeable increase in demand for rolled zinc is not in evidence, and neither can any be looked for now until the building industry begins to pick up again.

In the brass trade, too, encouraging news is unobtainable; in fact, a depressing note was struck by the announcement that the Hirsch works, in Germany, after operating at a full rate until mid-August, had been compelled to go on a short-time basis.

Thus, on the whole, there has not been anything to wax enthusiastic about in the consumptive demand for zinc during September, and the decline in stocks may be well below the figures the cartel was expecting to see by this time—even less than in June or July.

As far as business on the London Metal Exchange goes, that has certainly received a fillip, as is evidenced by the fact that the turnover for the first eighteen days of September aggregated 5,925 tons, whereas from the 21st to the 30th some 10,625 tons were traded. In so far as much of this business was of a speculative character, it is not a strong point for the market later on. Naturally, there has been some better buying by consuming interests, too, and this seems to have been dictated more by reasons of prudence than by an actual revival in trade.

The depreciated sterling exchange is affecting adversely the Mexican ore suppliers and not the European smelters, who have for some time past been paying a flat price for concentrates. Such a company as the San Francisco Mines of Mexico was enjoying only a modest profit on shipping its concentrates to Europe on this basis, and it may well prove that under the new British currency the profit on this business has virtually disappeared.

World stocks of zinc on Oct. 1, in metric tons, were estimated as follows:

	Metric Tons
United States	118,100
Europe	122,200
Rest of World	68,400
Total	308,700

Estimated world stocks of zinc on Sept. 1 totaled 309,900 metric tons.

E.&M.J. Weighted Index of Non-Ferrous Metal Prices

100 Is Composite for 1922-3-4

1920	130.92
1921	80.80
1922	93.94
1923	103.43
1924	102.63
1925	111.74
1926	107.74
1927	97.54
1928	99.78
1929	110.33
1930	82.87

	1929	1930	1931
January	106.86	102.94	67.62
February	110.37	102.28	65.90
March	122.71	99.93	68.03
April	116.36	93.24	64.45
May	110.03	83.41	59.81
June	109.66	78.57	58.23
July	109.58	74.58	59.54
August	109.81	74.41	58.05
September	109.29	73.42	57.09
October	106.52	69.63	....
November	106.09	71.39	....
December	104.75	70.65	....

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ALASKA JUNEAU in September mined and trammed to mill 356,900 tons, from which estimated results were as follows: Operating revenue, $315,000, or 88.26c. per ton; operating expenditures, $175,500, or 49.17c. per ton; operating profit, $139,500, or 39.09c. per ton; other expenditures exceeded other revenues by $500, leaving $139,000 to surplus for the month.

Western Electric Subsidiary to Buy Scrap and Sell Ingot

Western Electric Company will operate Nassau Smelting & Refining Works, Ltd., and Tottenville Copper Company, which it has purchased as of Nov. 1, as a subsidiary. It will not only reclaim its own scrap at the Tottenville plant, but will buy scrap material in the open market, and sell, over and above its needs, all the ingot metal products that the Nassau interests have been producing. The Nassau plant on West 29th St., New York, will be discontinued, and the metal-reclaiming operations that Western Electric has been carrying on at Kearny, N. J., will be transferred to the Tottenville, Staten Island, plant. It is understood, however, that Western Electric, after fulfilling Nassau's contracts, may increasingly use the plant for its own needs.

F. W. Willard has been made executive vice-president in charge of the new subsidiary. George H. Bangs will be manager of sales and purchases. Some of the emloyees of the purchased companies will go with Western Electric, including Max Jacoby. Metallurgical operations at the Tottenville plant will be in charge of W. A. Scheuch. When Western Electric takes over its subsidiary, offices will be established outside of 195 Broadway, where Mr. Willard and Mr. Bangs are now located.

Present plans do not include any changes in the Tottenville plant, nor the building of a copper refinery, as some trade rumors have had it. Western Electric is estimated to have been handling 25,000 to 30,000 short tons of non-ferrous scrap per year in the East.

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Financial Notes

BUNKER HILL & SULLIVAN, Idaho lead producer, reports profit in the first eight months of 1931 of $896,369, excluding depreciation or depletion. In 1930 the corresponding profit was $1,770,915. For August, profit was $130,991.

PLACER DEVELOPMENT, which has interests in New Guinea gold properties, reports a loss of $46,688 in the year ended April, 30, 1931. The profit-and-loss account showed a debit balance of $97,566.

BULOLO GOLD DREDGING, owner of placer properties in New Guinea, reports total assets of $1,985,654 on April 30, 1931. The company had spent $1,122,005 in equipment of its properties at that date. Current assets totaled $249,308.

ANACONDA COPPER will not pay any dividend in the last quarter of 1931. Omission of the dividend, which was 37½c. on common stock last quarter, resulted from low metal prices and low metal consumption.

U. S. Refined Lead Stocks Reduced in September

Stocks of refined lead at the end of September amounted to 132,804 tons, against a revised total of 134,977 tons at the end of August, and 133,958 tons in July, according to the American Bureau of Metal Statistics.

In the September United States lead refinery statistics a quantity of 3,895 tons of lead has been transferred from "in process of refining" to "refined," and the production under the head of refined has been increased by the same amount. This does not alter the total stock of lead previously reported, the stock of refined lead being increased and the stock in process being decreased by the same quantities. One plant, during August, the Bureau points out, began casting of lead in blocks of about 2,000 lb., to be subsequently remelted and molded, and reported this as being "in process," but, the lead being practically refined, it has appeared to be more proper to class it as such.

Production of lead from domestic ore during September was 31,966 tons, against 34,144 (revised) in August.

Shipments during September amounted to 38,059 tons, against 38,590 tons in August.

United States Lead Statistics

In tons of 2,000 lb:

Production:	August	September
From domestic ore	(b) 34,144	31,966
Secondary and foreign	5,453	3,934
Totals	(b) 39,597	35,900
Stock at beginning (a)	133,958	(b) 134,977
Total supply	(b) 173,555	170,877
Stock at end (a)	(b) 134,977	132,804
Shipments by difference	38,578	38,073
Shipments reported	38,590	38,059

(a) Domestic origin only. (b) Revised.

	June	July	August	September
Cable	8,877	10,726	9,250	7,818
Ammunition	1,328	2,210	1,795	1,986
Tin foil	1,233	1,597	915	505
Batteries	3,467	4,363	4,617	7,707
Brass-making	235	138	166	91
Sundries	2,677	2,397	2,061	879
Jobbers	346	378	322	142
Unclassified(a)	18,891	20,410	19,464	18,931
Totals	37,054	42,219	38,590	38,059

(a) Of the shipments reported as unclassified about one-third moves normally into white lead and about 30 per cent into red lead and litharge, as averages, but it is impossible to make a monthly segregation of the shipments according to these destinations. Other important manufactures are sheet and pipe, solder and babbitt metal.

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World Zinc Production Shows Downward Trend

Total production of zinc for all countries except Belgium during August was 73,689 tons, against 76,033 tons in July, and 80,555 tons in June, indicating that the trend continues downward. Belgian production averaged 13,250 tons in the first six months of the current year, and, according to unofficial reports, output in that country has followed the general downward trend in the last two months. Though zinc production has been curtailed in virtually all directions, consumption remains unsatisfactory, tending to depress the market abroad as well as in this country.

World zinc statistics for June, July, and August, compiled by the American Bureau of Metal Statistics, in short tons, follow:

	June	July	August
United States	23,483	21,365	21,467
Mexico	3,184	3,255	3,172
Canada	11,226	10,450	9,416
Belgium	(a)	(a)	(a)
France	5,786	5,707	5,171
Germany (b)	3,015	3,696	4,198
Italy	1,436	1,593	1,264
Netherlands	1,769	1,746	1,737
Poland (b)	13,417	12,017	10,618
Spain	936	957	946
Australia	6,255	6,847	6,500
Rhodesia	1,148	.....	.....
Elsewhere (c)	8,900	9,000	9,200
Totals	80,555	76,033	73,689

(a) Not reported. (b) Includes zinc dust. (c) partly estimated.

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World Silver Output Drops on Lower Prices

Latest data on world silver production indicate a monthly dropping of output, though statistics for some countries are delayed. The A.B.M.S. compilation, in thousands of fine ounces, follows:

	July	August	September
Mexico	6,390	.....	.....
United States	2,176	2,419	2,029
Canada	2,133	1,610	1,403
Peru	1,063	795	562
Australia	633	545	481
Burma	460	460	.....
Total	12,855	.....	.....

The monthly average production of the above countries, producing about 87 per cent of the world total, was 14,267,000 oz. in the first seven months of 1931, compared with 17,619,000 for the full year 1930. The downward trend in silver production is due to the low prices that have prevailed for some time in non-ferrous metals.

Stocks of silver in the United States at the end of September were 4,082,000 oz., compared with 2,240,000 oz. at the end of August. Canadian stocks decreased from 1,363,000 oz. to 989,000 oz.

Mining Company Dividends for September, 1931

Companies in the United States	Situation	Per Share	Total Disbursements
American Metal, 6% pfd	Various	$1.50 Q	103,014
American Smelting & Refining, 6% pfd	Various	1.50 Q	262,500
American Smelting & Refining, 7% pfd	Various	1.75 Q	875,000
Eureka Standard, g, s	Utah	0.03 Q	45,000
Freeport Texas Sulphur	Texas	0.75 Q	547,337
Golden Cycle, g	Colorado	0.40 Q	66,000
Hecla Mining, l, s	Idaho	0.10 Q	100,000
Homestake Mining, g	S. Dakota	1.50 MX	377,400
Mayflower Associates, h	Various	0.50 Q	136,500
National Lead	Various	1.25 Q	387,289
National Lead, pfd. "A"	Various	1.75 Q	426,433
Nevada Consolidated Copper	Nev., Ariz., N. M	0.20 Q	971,450
St. Joseph Lead	Various	0.25 Q	487,882
Texas Gulf Sulphur	Texas	0.75 Q	1,905,000
Tintic Standard Mining, s, l	Utah	0.10 Q	115,332
Utah Copper	Utah	1.50 Q	2,434,493
Companies in Other Countries			
Chile Copper	Chile	0.37½Q	1,655,813
Hollinger Consolidated Gold	Ontario	0.05 M	246,000
International Nickel, n, c	Ontario	0.10 Q	1,458,400
Lake Shore, g	Ontario	0.50 Q	500,000
McIntyre-Porcupine	Ontario	0.25 Q	199,500
Total			$13,300,343

s, silver; l, lead; c, copper; n, nickel; g, gold; q, quicksilver; h, holding company; Q, quarterly; M, monthly; X, plus extra.

World Copper Production Virtually Stable

World copper production has changed only slightly since June, in spite of the fact that the price has dropped from the June average of about 8¼c., delivered. In fact, the daily rate of world production increased slightly in August, and again in September. The A.B.M.S. figures for the last three months, in tons of 2,000 lb., based on the copper content of smelter production, allocated according to the place of smelting, follow. The "Elsewhere" is chiefly Africa.

World Copper Production

	July	August	September
United States	46,503	47,246	47,012
Chile and Peru	24,611	23,334	23,020
Canada	9,837	10,586	10,497
Japan	7,014	6,619	6,860
Mexico	3,970	4,405	3,674
Australia	1,271	1,176	1,510
Germany	4,698	5,389	4,816
Other Europe	11,600	11,500	11,600
Elsewhere	12,000	11,400	11,700
Total	121,504	121,655	120,689
Daily rate	3,919	3,924	4,023

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Financial Notes

COROCORO UNITED COPPER, largest copper producer in Bolivia, reports a loss of £10,058 on operations in 1930, according to the annual report, just issued. In 1929, the profit was £17,622. The mine was closed in 1930.

TECK-HUGHES GOLD, gold producer in Ontario, reports a net profit of $863,078 in the quarter ended Aug. 31. Gross income was $1,598,545 and the gross profit, before depreciation or taxes, $1,035,517.

U. S. SMELTING, REFINING & MINING reports net profit of $1,241,982 in the first eight months of 1931, compared with $2,282,105 in the corresponding period of 1930. These figures include deductions for depreciation and development. Dividend payments of $3.50 on the preferred stock annually and $1 on the common are being maintained.

Copper Holds at 7c.—Lead and Zinc Lower

New York, Oct. 22, 1931

As many in the trade anticipated, demand for copper increased somewhat with the approach of the date on which the first gathering of officials of the industry is to take place. The first informal gathering is scheduled for today. The demand for copper in the last two weeks has not been sufficient to result in any change in the price, the market remaining in the hands of the custom smelters on the basis of 7c. per pound, delivered Connecticut. Owing to the uncertainty as to the outcome of the meetings of the leaders in the industry, sellers were not disposed to take a definite stand on the market, and, apparently, fabricators shared in this view, for the market was a most orderly affair under present circumstances. Brass mills reported a slight gain in specifications for the period, but wire and cable makers noted little if any change in the situation.

Continued quiet demand for lead, with the result that smelters were unable to dispose of their current intake, led to a reduction of one-quarter cent in the American Smelting & Refining Company's contract price on Tuesday, Oct. 20, bringing the New York quotation to 3.75c., equaling the low for the year, which obtained from May 11 to June 20. The principal producer in the Middle West cut the price 30 points instead of 25, probably to widen its competitive field in the East and to increase the outlet for its new brand of desilverized lead in the Middle West. The current St. Louis price of 3.525c. is a new low for the last seventeen years.

Demand for zinc failed to register any improvement, and moderate offerings sufficed to bring out renewed weakness in prices. At the outset of the last week Prime Western zinc sold at 3.35c. per pound, St. Louis, prompt shipment. Later in the period more than one lot of nearby zinc sold at 3.30c., and just before the close the tone was anything but firm. Except for the very quiet condition of the consuming industries, producers say that nothing has occurred to upset the market.

Demand for tin has again been exceedingly quiet, and price changes have been slight, ranging a little above and below 23c. for prompt Straits throughout the period.

With but few exceptions, the silver market remained quiet, prices fluctuating between 29.25c. and 30.25c. Sales by China against small purchases to cover India bear position and a continuation of purchases for speculative account have featured the market.

Other Metals

Quotations cover wholesale lots, f.o.b. New York, unless otherwise specified. London prices are according to latest mail advices, and this week are largely nominal in view of erratic sterling exchange.

ALUMINUM—Per lb., delivered, Alcoa commercial and mill ingot, 99 and 98 per cent, 23.30c.; Alcoa No. 12 alloy, 22c.; metallurgical ingot, 94 per cent plus, 23.30c.; 98@99 per cent, 22.90c. London, £95, less 2 per cent, per long ton, for 98 per cent ingots and bars.

ANTIMONY—Per lb., duty paid, Chinese, spot, 6.50@6.55c.; futures, 6.35c., nominal. Cookson's "C" grade, spot, 11½c. "CMC." grade, 99.9 per cent, spot, 11c.

BERYLLIUM—See Alloys.

BISMUTH—Per lb., in ton lots, $1.15. London, 4s. 9d.

CADMIUM—Per lb., 55c. London, 2s. Nominal.

CHROMIUM—Per lb., 97@98 per cent grade, 85@90c. per lb. contained chromium, maximum 1 or 2 per cent iron. (Usually sold as ferrochrome.)

COBALT—Per lb.: Metal imported from Belgium, 97@99 per cent, $2.50 less 35 per cent for cash. On yearly requirements, usual rebate of 5 to 10 per cent, as to quantity. London quotes $3.75 per kilo, subject to usual discounts.

INDIUM—Per oz., 98½ per cent, $90@$100 per oz. Nominal.

IRIDIUM—Per oz., $90@$100 for 98@99 per cent sponge and powder. London, £22. Nominal.

LITHIUM—Per lb., 98@99 per cent, 100-lb. lots, $15.

MAGNESIUM—Per lb., ingots (4x16 in.), 99½ per cent, 30c. in carloads; 32c. in 100 lb. lots or more, l.c.l.; ⅜, ½, 1, and 2 pound sticks, 5c. per pound over ingot price; ⅛ and ¼ pound sticks, 8c. per pound extra.

MANGANESE—Per lb., 95@97 per cent, 42c. (Usually sold as ferromanganese.)

MOLYBDENUM—Per lb., in 10- to 50-lb. lots, C.P. powder, $9; 97 per cent, $4.50. (Usually sold as calcium molybdate or ferromolybdenum, which see.)

NICKEL—Per lb. electrolytic cathodes, 35c.; shot and ingot made from remelted electro, 36c. for single lots of spot metal. London, per long ton, £215 to £220, with prices nominal owing to the unsettlement in exchange.

OSMIUM—Per oz., $60@$65. London, £13.

PALLADIUM—Per oz., $19@$21. London, £3 12s. 6d.@£4.

PLATINUM—Per oz. Official price of leading interest $40. Cash transactions between dealers and refiners several dollars less. London market nominal at £9 14s. to £10.

QUICKSILVER — Per 76-lb. flask, $70@$72. Sales of less than 25-flask lots were reported at $72. Demand quiet. London quotes £20 10s., with market nominal:

RADIUM—Per mg. radium content, $50 in lots of 4 grams or more, to $65 for 1 gram; smaller quantities, $70.

RHODIUM—Per oz., $45@$50.

RUTHENIUM — Per oz., $38@$42. London, £8 10s. Nominal.

SELENIUM—Per lb., $1.80@$2, depending on quantity, for black, powdered, 99.5 per cent pure.

SILICON—Per lb., minimum 97 per cent Si, maximum 1 per cent Fe, 15@17c.

TANTALUM—Per kilo, $91 for C.P. bar or sheet.

TELLURIUM—Per lb., $2. London, 9s.@9s. 6d.

THALLIUM—Per lb., $12.50@$15.

TITANIUM—Per lb. in 50- to 100-lb. lots, 75 per cent, $5.

TUNGSTEN—Per lb. contained tungsten, 98 per cent, powdered, $1.45.

Metallic Ores

Prices in tons of 2,000 lb., or in "units" of 20 lb., unless otherwise stated.

ANTIMONY ORE—No sales reported. London, per long ton unit, 3s.@3s. 6d. for 60 to 65 per cent sulphide ore.

BERYLLIUM ORE—Per ton, minimum 10 per cent BeO, $20@$30, f.o.b. mines. Supplies more than adequate. Export, small lots, $20@$60.

CHROME ORE—Per long ton, c.i.f. Atlantic ports, Indian ores, $17.50 for 46@48 per cent Cr_2O_3 ore, and $19.50@$20 for 50@51 per cent ore. London, 74s. to 75s. for 48 per cent, with contract Rhodesian held at 80s. High-grade Indian and New Caledonian, 90s.@100s.

COBALT ORE—Per lb. of Co, 12 to 14 per cent grade, 50c., f.o.b. cars, Ontario. Market nominal.

IRON ORE—Per long ton, Lower Lake ports. Lake Superior ores:

Mesabi, non-bessemer, 51½ per cent iron, $4.50. Old Range, non-bessemer, $4.65.

Mesabi, bessemer, 51½ per cent iron, $4.65. Old Range, bessemer, 51½ per cent, $4.80.

Eastern ores, cents per long ton unit, delivered at furnaces: Foundry and basic, 56 to 63 per cent, 10c.

Foreign ores, alongside docks Atlantic ports, cargo lots, cents per long ton unit:

North African and Swedish, low-phosphorus, 8½@9½c.

Spanish and North African, basic, 50@60 per cent, 8½@9c.

Swedish foundry or basic, 65@68 per cent, 9c.

Newfoundland foundry, 55 per cent iron, 8½c. Nominal.

MANGANESE ORE—Per long ton unit of Mn, c.i.f. North Atlantic ports,

Daily Prices of Metals

Oct.	Electrolytic Copper	Straits Tin	Lead		Zinc
	Refinery	New York	New York	St. Louis	St. Louis
8	6.775	22.25	4.00	3.825	3.50
9	6.775	22.875	4.00	3.825	3.50
10	6.775	23.125	4.00	3.825	3.50
12			Holiday		
13	6.775	23.125	4.00	3.825	3.45
14	6.775	23.35	4.00	3.825	3.40
Av'ge	6.775	22.945	4.000	3.825	3.470
15	6.775	23.30	4.00	3.825	3.35
16	6.775	22.95	4.00	3.825	3.35
17	6.775	22.75	4.00	3.825	3.35
19	6.775	22.70	4.00	3.825	3.30
20	6.775	22.95	3.75	3.525	3.30
21	6.775	23.00	3.75	3.525	3.30
Av'ge	6.775	22.942	3.917	3.725	3.325

Average prices for calendar week ended October 10, 1931, are: Copper, 6.775c.; Straits tin, 22.521c.; New York lead, 4.000c.; St. Louis lead, 3.825c.; Zinc, 3.527c; Silver 29.292c.

Average prices for calendar week ended October 17, 1931, are: Copper, 6.775c.; Straits tin, 23.095c.; New York lead, 4.000c.; St. Louis lead, 3.825c.; Zinc, 3.380c.; Silver, 29.675c.

The above quotations are our appraisal of the major markets for domestic consumption based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

Copper, lead, and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

In the trade, copper prices are quoted on a delivered basis; that is, delivered at consumer's plant. As delivery and interest charges vary with the destination, the figures shown above are net prices of refineries on the Atlantic seaboard. Delivered prices in New England average 0.225c. per pound above those quoted.

Quotations for copper are for the ordinary forms of wirebars and ingot bars. For ingots an extra 0.05c. per pound is charged; for slabs, 0.075c.; and for cakes, 0.125c. up depending on weight. Cathodes are sold at a discount of 0.125c. per pound.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York is now quoted at 0.35c. per pound above St. Louis, this being the freight differential. The contract price for High-Grade zinc delivered in the East and Middle West is 1c. above the St. Louis price for Prime Western.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

Silver, Gold, and Sterling Exchange

Oct.	Sterling Exchange "Checks"	Silver		Gold, London	Oct.	Sterling Exchange "Checks"	Silver		Gold, London
		New York	London				New York	London	
8	3.82	29 3/8	17 5/16	107s 8d	15	3.86	29 1/4	17	106s 6d
9	3.87	29 3/4	17 3/8	107s....	16	3.84 1/2	29 7/8	17 3/8	106s 11d
10	3.89	29 7/8	17 7/16	.....	17	3.85 1/2	30	17 9/16	.....
12	Holiday	Holiday	17 1/2	106s 9d	19	3.87	30 1/4	17 5/8	106s 8d
13	3.89	29 3/4	17 1/4	106s 6d	20	3.93	30	17 1/8	105s 9d
14	3.87	29 1/2	17 1/8	106s 6d	21	3.95	29 3/4	16 7/8	104s 8d

Average for week ended October 14: Silver, 29.650c.; Sterling exchange, $3.86800.

Average for week ended October 21: Silver, 29.854c.; Sterling exchange, $3.88500.

New York quotations are as reported by Handy & Herman and are in cents per troy ounce of silver, 999 fine. London silver quotations are in pence per troy ounce of bar silver, basis of 925 fine. Sterling quotations represent the demand market in the forenoon. Cables commanded one-half cent premium at noon on Oct. 21.

London

Oct.	Copper Standard		Electrolytic (Bid)	Tin		Lead		Zinc	
	Spot	3 M		Spot	3 M	Spot	3 M	Spot	3 M
8	34 7/16	35 7/16	41	125	129 1/8	12 3/4	12 15/16	12 3/8	12 15/16
9	34 3/8	35 7/16	41	127 1/2	129 3/4	12 15/16	13 1/8	12 11/16	13 1/4
12	34 3/4	35 3/4	41	129	131 1/4	13 1/4	13 7/16	12 7/8	13 1/2
13	35 3/4	36 1/4	41 1/2	130 1/2	132 1/4	13 1/2	13 5/8	13	13 9/16
14	35 1/2	36 5/16	41 1/2	130 3/4	132 3/4	13 3/4	13 7/16	12 13/16	13 5/16
15	34 7/8	35 5/8	41 1/2	131	133 1/4	13 1/4	13 5/16	12 1/2	13
16	34 13/16	35 5/8	40 1/2	130 7/8	133	13 3/16	13 1/4	12 7/16	13
19	35 9/16	36 5/16	40 1/2	128 3/8	130 3/4	13 1/4	13 3/8	13	13 1/2
20	35 11/16	36 5/16	40 1/2	127 1/8	129 1/2	13 5/16	13 5/16	13	13 1/2
21	35 5/8	36 3/8	40 1/2	127 3/4	130 1/8	13 3/8	13 3/8	13 1/8	13 5/8

Prices for lead and zinc are the official price for the morning session of the London Metal Exchange; prices for copper and tin are the official closing buyers' prices. All are in pounds sterling per long ton (2,240 lb.).

cargo lots, exclusive of duty: Brazilian, 46@48 per cent Mn, 23c.; Chilean, 47 per cent minimum, 29c.; Indian, 48@50 per cent, 25@26c.; Caucasian, 52 @55 per cent, 26c.; South African, 52@54 per cent, 23@25c.; 50 to 52 per cent, 22@24c.; 44 to 46 per cent, 21½c. Prices almost entirely nominal as market is very dull.

Per ton in carload lots:

Chemical grades, powdered, coarse or fine, minimum 80 per cent MnO_2, Brazilian or Cuban, $50 in carloads, to $60 barreled. Javan or Caucasian, 85 per cent minimum, $50@$60. Domestic, 70 to 72 per cent, $43@$50 in carloads, f.o.b. mines.

Molybdenum Ore—Per lb. of contained MoS_2, nominally 45c., delivered Pittsburgh, for 75@85 per cent concentrate. London, per long ton unit, nominal at 28s. 6d. to 30s. for 80@85 per cent concentrate.

Tantalum Ore—Per lb. Ta_2O_5, 70c. for 60 per cent ore. Market nominal.

Tin Ore — No market in United States. London market virtually at standstill as no supplies are moving. Returning charges nominal owing to exchange situation.

Titanium Ore — Per gross ton, ilmenite, 45@52 per cent TiO_2, f.o.b. Atlantic seaboard, $10@$12, according to grade and impurities. Low-grade domestic, 32 to 35 per cent, about $7 @$8. Rutile, per lb., guaranteed minimum 94 per cent concentrate, 10c.

Tungsten Ore—Per unit of WO_3, N. Y.: Chinese wolframite, $11@$11.25, duty paid. Bolivian scheelite, $10.60. Domestic, $9.50 to $12. Actual sales reported at inside figure. Market dull.

Vanadium Ore—Per lb. V_2O_5 contained, 27c., f.o.b. shipping point. London, prices withdrawn temporarily.

Zircon Ore — Per ton, 55 per cent ZrO_2, f.o.b. Atlantic seaboard, $40@$45 in 30-ton lots. Crude granular zircon, $70, f.o.b. Suspension Bridge, N. Y.; milled, $90.

Non-Metallic Minerals

Prices received for non-metallic minerals vary widely and depend upon the physical and chemical characteristics of the commodity. Hence the following quotations can serve only as a general guide to the prices obtained by producers and dealers in different parts of the United States for their own product. In the last analysis the value of a particular non-metallic mineral can be ascertained only by direct negotiation between buyer and seller.

Tons of 2,000 lb. unless otherwise noted.

Amblygonite — Per ton, f.o.b. mines, 8@9 per cent Li_2O, $50@$60.

Asbestos — Per ton, f.o.b. Quebec mines, tax and bags included: Crude No. 1, $400@$450; crude No. 2, $200@ $250; spinning fibers, $90@$175; magnesia and compressed sheet fibers, $100@$125; various grades shingle stock, $45@$65; various grades paper

stock, $27.50@$35; cement stock, $15@$20; floats, $10@$12.

Per ton c.i.f. New York: Rhodesian crude No. 1, $300; No. 2, $200. Nominal.

Per ton, c.i.f. New York: Russian crude No. 1, $225@$250; No. 2, $175@$200; No. 3, $125@$150. Nominal.

Per ton, f.o.b. mines, Vermont: Shingle stock, $45; paper stock, $35; cement stock, $20.

BARIUM CARBONATE (Witherite) — Per ton, 90 per cent 300 mesh, $42; 100 mesh, $39.

BARYTES—F.o.b. mines:

Georgia: Barytes ore, crude, $6@$6.50 per long ton.

Missouri: Per ton, water ground and floated, bleached, $23, car lots, f.o.b. works. Crude ore, minimum 95 per cent $BaSO_4$, less than 1 per cent iron, $6; 1 per cent iron and 93 per cent $BaSO_4$, $5.50, f.o.b. mines.

BAUXITE—Per long ton: Domestic ore, chemical, crushed and dried, 55 to 58 per cent Al_2O_3, 1.5 to 2.5 per cent Fe_2O_3, $6.50@$8, f.o.b. *Alabama* and *Arkansas* mines. Other grades, 56 to 59 per cent Al_2O_3, 5 to 8 per cent SiO_2, $6@$7.50, f.o.b. *Arkansas* mines. Pulverized and dried, 56 to 59 per cent Al_2O_3, 8 to 12 per cent SiO_2, $10@$12.25, f.o.b. *Arkansas* mines; abrasive grade, crushed and calcined, 78 to 84 per cent Al_2O_3, $14@$16, f.o.b. *Arkansas* mines.

Per metric ton, foreign, c.i.f. Atlantic ports: Dalmatian, 50 to 55 per cent Al_2O_3, 1 to 3 per cent SiO_2, $4.50@$6.55. Istrian, 54 to 57 per cent Al_2O_3, 3 to 5 per cent SiO_2, $5.50@$7; French, 56 to 59 per cent Al_2O_3, 2 to 4 per cent SiO_2, $6@$8.

BENTONITE—Per ton, carload lots, f.o.b. *Wyoming* mines, dried and crushed, in bulk, $8; in bags, $10. F.o.b. Chicago, selected air-floated, $25.

BORAX — Per ton, carload lots, in bags, crystals, $56; granulated, $50; powdered, $57.50; f.o.b. shipping point.

[1]CELESTITE—Per ton in carload lots, 90 per cent $SrSO_4$, finely powdered, $27.

CHINA CLAY (KAOLIN)—Per ton, f.o.b. *South Carolina* mines, crude lump, No. 1, $5; crushed air-floated, $7; pulverized, $9@$10.

Florida, washed and crushed, No. 1, $12.50; No. 2, $12.

Delaware, No. 1, $14.50.

Imported English, f.o.b. American ports: lump, $17@$21 in bulk.

DIATOMITE—Per ton, f.o.b. *Nevada,* crude, dried, in bags, $10; minus 40 mesh, $15; 300 mesh, $20; high temperature insulation, $30.

EMERY—Per ton, f.o.b. *New York,* domestic crude ore, first grade, $10. Other American ore, delivered to grinders, per gross ton, $15; Turkish and Naxos ore, $30@$35. F.o.b. *Pennsylvania,* in 350-lb. kegs, Turkish, Khasia, and Naxos grain emery, 6½c. per lb.; American, 3½c.

FELDSPAR — Per ton, f.o.b. *North Carolina,* potash feldspar, 200 mesh, white, $15, in bulk; soda feldspar, $18. F.o.b. *Maine,* potash feldspar, white, 200 mesh, $19, in bulk. Granular glasspar, f.o.b. *North Carolina,* $10.50 in bulk.

Virginia, No. 1, 325 mesh, $17; 200 mesh, $15@$16; 160 mesh, $14@$15; No. 1 glassmakers', $11; enamelers', $12.50.

New Mexico: Crude clean No. 1 potash spar, $4.75; ground, $9.50.

FLUORSPAR — Per ton, f.o.b. *Kentucky* and *Illinois* mines:

Gravel, not less than 85 per cent CaF_2, and not over 5 per cent SiO_2, bulk basis, $13. Foundry lump, 85-5, $15. Ground, 95 to 98 per cent CaF_2, and not over 2½ per cent SiO_2, $30 in bulk; $34 in bags or barrels. *Colorado* mines, 82-5, $10.

Foreign fluorspar, gravel, 85-5, $18.50 per gross ton, duty paid.

FULLER'S EARTH — Per ton, f.o.b. *Colorado,* $18, various finenesses to minus 90 mesh.

F.o.b. *Georgia* or *Florida,* 30 to 60 mesh, $16: 15 to 30, $15; 200 up, $10; 100 up, $7.

GARNET—Per ton, f.o.b. *New Hampshire* mines; concentrate, $40; washed grades, $125.

New York: Adirondack garnet concentrates, $85.

Spanish grades, $60, c.i.f. port of entry.

GILSONITE — Per ton, carload lots, f.o.b. *Colorado:*

Brilliant black, $32.90; seconds (mine run), $25.50.

Selects, $30.50, f.o.b. Utah. Nominal.

GRAPHITE—Per lb., f.o.b. *New York:* Ceylon lump, 6½@7½c.; carbon lump, 3@6c.; chip, 5@6c.; dust, 3@4c.; Madagascar flake, 5@6c.

No. 1 flake, 8@16c.; No. 2, 5c upward; fine ground, 3c. upward; amorphous, 3c. upward.

Crude amorphous graphite, $15@$35 per ton, according to grade.

GREENSAND—Per ton, f.o.b. cars, *New Jersey:* Screened and bagged, best grade, in carload lots, $20.

GYPSUM—Per ton, f.o.b. mill, crushed rock, *Iowa,* $2.50; *Ohio* and *New York,* $3. Ground, *Ohio,* $4; *Iowa,* $6. Agricultural, $6@$7. Calcined, $6@$9.

IRON OXIDE (See Ocher)—Per lb.: Standard Spanish red, 3@4½c.; domestic earth, 2@4½c.

KAOLIN—See China Clay.

KIESELGUHR—See Diatomite.

LEPIDOLITE—Per ton, $50@$60 for ordinary grades. Nominal.

LIMESTONE—Per ton, f.o.b. shipping points, depending on location, either lump or crushed, 25c.@$1.75.

Agricultural, $1 up to $6 per ton, as to grade and point of shipment.

MAGNESITE—Per ton, f.o.b. *California,* dead-burned, $25. Kiln run, 93 per cent MgO (artificial periclase), $68; 88 per cent MgO, $35. Caustic, 95 per cent MgO, $45; 90 per cent, $40. *Washington:* Dead-burned grain magnesite, $22.

MICA—Per ton, f.o.b. *New Mexico,* scrap, white, $21; off color, $18. Punch, white, for disks, per lb., 10c.; for washers, 8c.

Per ton, f.o.b. *New Hampshire,* roofing mica, $23; snow, $34; 40 mesh white, $40; 60 mesh, $48; 100 mesh, $60; 200 mesh, $75. Clean dry mixed bench and mine scrap, $13.

Per lb., f.o.b. *North Carolina:* Punch, 3@5c.; 1½x2 in., 20@30c.; 2x2, 30@50c.; 2x3, 60@90c.; 3x3, $1@$1.40; 3x4, $1.40@$1.80; 3x5, $1.50@$2; 4x6, $2.25@$3; 6x8, $2.50@$3.75; 8x10, $5@$7.50. These prices apply both to No. 1 and No. 2 mica. Black-stained mica takes a discount of 10 to 25 per cent from this schedule. White North Carolina mica, 70 mesh, $60 to $80. Biotite, or black mica, $15 a ton, unground. Market is quiet and prices are more or less nominal.

MINERAL BLACK—(Graphitic shale) —Per ton, 325 mesh, 75 per cent carbon, $22.50, f.o.b. *Virginia.*

MONAZITE—Per ton, minimum 6 per cent ThO_2, $60.

OCHER — Per ton, f.o.b. *Georgia* mines, $17.50 in sacks; $22 in barrels. Buff clay, 98 per cent through 325 mesh, $18.

F.o.b. *Virginia,* dark yellow, 300 mesh, 60 per cent ferric oxide, in jute bags, $19.50.

PHOSPHATE—Per long ton, f.a.s. or f.o.b. mines:

Florida, pebble, f.a.s., for export: 76@77 per cent, $7.15; 75 per cent, $6.40; 74@75 per cent, $6.15; 70 per cent, $4.65; 68 per cent, $4.10.

Florida, pebble, domestic: 76@77 per cent, $6.50; 74@75 per cent, $5.50; 72 per cent, $4.50; 70 per cent, $4.

Tennessee, ground lime phosphate, 80 per cent through 300 mesh, 33 per cent P_2O_5, $12.80 per net ton, bags extra.

PUMICE STONE—Per lb., in barrels, powdered, 2½@4c.; selected lump, 5@7c.

PYRITES—Per long ton unit of sulphur, c.i.f. United States ports, guaranteed 48 per cent sulphur, Spanish, 13c.

POTASH—Per ton, contracts:

	Bags	Bulk
Muriate of potash, 80@85 per cent, basis 80 per cent	$37.15	$35.55
Sulphate of potash, 90@95 per cent, basis 90 per cent	48.25	46.65
Sulphate of potash-magnesia, 48@53 per cent, basis 48 per cent	27.80	26.20
Manure salt, 30 per cent	22.15	19.15
Manure salt, 20 per cent	15.65	12.65
Kainit, 14 per cent	12.70	9.70

Prices are delivered to Atlantic ports. Discounts up to 4 per cent for early shipment. Spot prices, $1.25@$1.50 per ton higher than on contract.

[1]QUARTZ ROCK CRYSTALS—For fusing, all sizes, $250 per ton. Prisms for piezo-electrical and optical use command premium.

SILICA—Per ton, water ground and floated, in bags, f.o.b. *Illinois:* 325 mesh, $16@$40 for 92 to 99½ per cent grades. Dry ground, air-floated, 325 mesh, 92@99½ per cent silica, $14@$30. Market steady. Glass sand, f.o.b. producing plant, $1.25@$5 per ton; molding sand, 50c.@$3.50; blast sand, $1.75@$6.

[1]STRONTIANITE — Per ton, lump in carload lots, minimum 90@92 per cent $SrCO_3$, $100.

SULPHUR—Per long ton for domestic market, $18 f.o.b. Texas mines; $22 for export, Atlantic ports.

TALC — Per ton, carload lots, f.o.b. works, containers included unless otherwise specified:

New Jersey: Soapstone, ground, $10@$12.

New York: Double air floated, short fiber, 200 mesh, $13.75; 325 mesh, $14.75.

Vermont: 99 per cent through 200 mesh, extra white, bulk basis, $8@$8.50; 97 to 98 per cent through 200 mesh, medium white, $7@$7.50. Packing in paper bags, $1 per ton extra.

Virginia: 200 mesh, $4.60@$8.25; 325 mesh, $8.75@$10.50.

TRIPOLI — Per ton, burlap bags, paper liners, minimum carload 30 tons, f.o.b. *Missouri:* Once ground through 40 mesh, rose and cream colored, $15. Double ground through 110 mesh, rose and cream, $17. Air-floated through 200 mesh, rose and cream, $22.50.

Metallic Compounds

ARSENIOUS OXIDE (White arsenic)—Per lb., 4c., delivered, all positions. London, per long ton, £20 10s to £21; prices nominal for Cornish white. Mexican, high grade, £18 10s. Nominal.

CALCIUM MOLYBDATE OR MOLYTE—Per lb. of contained Mo, 85c.

COBALT OXIDE—Per lb., black oxide, 70@71 per cent grade, $1.35. Some German material has been offered here at $1.20.

COPPER SULPHATE (Blue Vitriol)—Per lb., in car lots, 3.40c. for either large or small crystals.

SODIUM NITRATE—Per 100 lb., crude natural, in bags ex vessel, Atlantic ports, $1.80.

SODIUM SULPHATE (Salt Cake)—Per ton, bulk, f.o.b. works, $16@$18.

ZINC OXIDE—Per lb. in bags, in car lots: Lead-free, 6½c.; 10, 20 or 35 per cent leaded grades, 6¼c.; French red seal, in bags, 9⅜c.

ZIRCONIUM DIOXIDE—Per lb. in 100- to 500-lb. lots, 87 per cent ZrO_2, commercial, 50c.

Refractories

CHROME BRICK—Per ton, f.o.b. shipping point, $45. Grecian refractory ore, 37@42 per cent, 40c. per unit.

FIRECLAY BRICK — Per M., first quality, $40, *Ohio, Kentucky, Central Pennsylvania;* second quality, $35.

MAGNESITE — Brick, per ton, f.o.b. works, 9-in. straights, $65. Dead-burned grain, $40, f.o.b. Chester, Pa., or Baltimore.

SILICA BRICK—Per M., *Pennsylvania,* $40: *Alabama,* $50@$51; *Illinois* and *Indiana,* $49.

ZIRKITE—Per lb., powdered, 65@70 per cent ZrO_2, 3½c. Brick, straights, 80c.@$1 each.

Alloys

BERYLLIUM—Per lb. of contained Be, $50, chiefly sold as an alloy of 12 per cent Be and 88 per cent Cu.

FERROCHROME — Per lb. of contained chromium, 4 to 6 per cent carbon, 65 to 70 per cent chromium, 11c., delivered, on contracts; spot, 11½c. Containing 2 per cent carbon, 67 to 72 per cent chromium, spot, 17½c.; maximum 0.10 per cent carbon, 26c., spot; 24½c. contracts.

FERROMANGANESE — Per gross ton furnace: domestic and foreign, 78@82 per cent, $80@$85, contracts, depending on quantity. Spiegeleisen, 19@21 per cent, $30 for spot carloads.

FERROMOLYBDENUM—Per lb. of Mo, f.o.b. shipping point, 50@60 per cent Mo, $1.

FERROPHOSPHORUS—Per gross ton, 18 per cent P, $91; electrolytic, 24 per cent, $122.50, f.o.b. *Alabama* and *Tennessee.*

FERROSILICON — Per gross ton, delivered, 50 per cent, $83.50; 75 per cent, $130; 14@16 per cent, $31, f.o.b. Niagara Falls, N. Y. Spot shipments $5@$10 per ton higher on 50 and 75 per cent grades.

FERROCARBONTITANIUM — Per ton, $150, f.o.b. producer's plant, carlots.

FERROTUNGSTEN—Per lb. of W contained, 75@80 per cent W, $1@$1.10, f.o.b. works.

FERROVANADIUM—Per lb. of V contained, delivered, $3.15@$3.50.

SILICOMANGANESE — Per long ton, carload contracts, delivered, $105 for maximum 2½ per cent carbon; $115 for maximum 1 per cent carbon.

SILICON ZIRCONIUM—Per lb., 47@52 per cent Si, 35@40 per cent Zr, 18@21c.

ZIRCONIUM FERROSILICON—Per gross ton, 12@15 per cent Zr, 39@43 per cent Si, $103.50@$108.50.

Rolled Metals

Effective Oct. 1, producers of rolled copper and brass products revised their base price to apply against 1,000-lb. lots instead of 100-lb. lots. Published list prices, as a result of this change, show a reduction of 1c. to 4c. per pound.

COPPER — Per lb., sheets, hot-rolled, 16⅛c.; wire, f.o.b. mill, 9c.

LEAD SHEETS—Per lb., full rolled, 7c.; clipped, 7¼c.

MONEL METAL—Per lb., sheets, full finished, 42c.; strip, cold-rolled, 45c.; rods, hot-rolled, 35c.

MUNTZ METAL—Per lb., rods, 12¼c.; plates, 15⅛c.

NICKEL—Per lb., sheets, full finished, 52c.; rods, hot-rolled, 45c.

NICKEL SILVER — Per lb., sheets, 10 per cent, 19⅞@20¼c.; 18 per cent, 23⅛@23¾c. Wire and rods, 10 per cent, 23⅜c.; 15 per cent, 27⅜c.; 18 per cent, 30⅞c.

PHOSPHOR BRONZE—Per lb., sheets and rods, 5 per cent tin, 25⅜c.; wire, 5 per cent, 25⅞c.; 10 per cent, 30⅜c.

ZINC SHEETS—Per lb., 9c., f.o.b. works; ribbon, 8½c.; 7 per cent discount on orders for 18 tons or more.

Iron, Steel, and Coke

IRON—Per gross ton, Valley furnaces: Bessemer, $17; basic, $17; and No. 2 foundry, $17.

STEEL—Per gross ton, base prices, Pittsburgh, billets and slabs, $29; bars, plates, and structural shapes, per 100 lb., $1.60.

COKE—Per ton, Connellsville furnace, $2.40@$2.50. Connellsville foundry, $3.25@$4.50. Birmingham furnace, $3.50@$4.50. Byproduct coke, Ohio and Kentucky (Connellsville basis), $5.50; Buffalo and Detroit, $8@$8.50; Birmingham foundry, $5.

[1]Price furnished by Foote Mineral Company, Philadelphia.

Mining Share Prices—Month of September, 1931

Company Name	High	Low	Last	§Most Recent Dividend
NEW YORK STOCK EXCHANGE				
Alaska Juneau	20	11⅝	12	Oc. 10, No. 2, 1931....Q 0.10
American Metal	11	5.00	7.00	December, 1930.....Q 0.25
Am. Metal, pfd	51	41	41	Au. 22, Se. 1, 1931.....Q 1.50
Am. Sm. & Ref	31½	19⅜	22¼	Oc. 16, No. 10, 1931...Q 0.37½
Am. Sm. & Ref. 2nd pfd.	86	72½	72½	No. 6, De. 1, 1931.....Q 1.50
Am. Sm. & Ref. 1st pfd.	123½	99½	103	No. 6, De. 1, 1931.....Q 1.75
Am. Zinc, L. & S	5.00	3.00	3.37½	May, 1917..... 1.00
Am. Zinc, L. & S., pfd.	38½	26	26	October, 1930.....Q 1.50½
Anaconda	25	15	15	Jy. 11, Au. 17, 1931.....Q 0.37½
Andes Copper	8.25	7.00	7.00	Ja. 10, Fe. 9, 1931.....Q 0.25
Butte C. & Z	0.87½	0.75	0.75	December, 1929..... 0.50
Butte & Superior	1.75	1.12½	1.25	December, 1929.....Q 0.50
Callahan Zinc-Lead	0.62½	0.50	0.50	December, 1920..... 0.50
Cal. & Arizona	38	23⅛	24	June, 1930..... 0.50
Cal. & Hecla	6.25	4.00	4.00	June, 1930..... 0.50
Cerro de Pasco Copper	18	9.87½	14	Jy. 16, Au. 1, 1931.....Q 0.25
Dome Mines	12½	7.25	7.25	Je. 30, Jy. 20, 1931.....Q 0.25
Federal M. & S	25	20	25	June, 1927..... 10.00
Federal M. & S., pfd	50	48	50	My. 25, Je. 5, 1931....Q 1.75
Freeport Texas	27	17	17⅛	No. 15, De. 1, 1931....Q 0.75
Granby Con	11⅛	7.50	7.50	Oc. 16, No. 2, 1931....Q 0.25
Greene Cananea	.....	.....	73½*	July. 1930..... 0.75
Homestake	120	89½	94	Se. 19, Se. 25, 1931..MX 1.50
Howe Sound	19⅛	13⅜	14⅝	Je. 30, Jy. 15, 1931....Q 0.50
Inspiration	6.12½	3.62½	4.37½	July, 1930..... 0.50
International Nickel	13½	8.00	8.00	Au. 31, Se. 30, 1931...Q 0.10
Int. Nickel, pfd	120	92	92	Oc. 3, No. 2, 1931.....Q 1.75
Kennecott Copper	17⅞	10½	11⅞	Je. 11, Jy. 1, 1931.....Q 0.25
McIntyre Porcupine	22½	12⅜	12⅜	No. 2, De. 1, 1931.....Q 0.25
Magma Copper	13½	7.37½	7.37½	Je. 30, Jy. 15, 1931....Q 0.25
Miami Copper	6.00	2.75	3.75	August, 1930..... 0.375
Mother Lode	0.50	0.25	0.50	June, 1930..... 0.10
National Lead	103⅜	85	85	Se. 11, Se. 30, 1931....Q 1.25
National Lead, pfd. A	142	140	140	Au. 28, Se. 15, 1931....Q 1.75
National Lead, pfd. B	118	118	118	Oc. 16, No. 2, 1931....Q 1.50
Nevada Con	8.37½	5.50	5.50	Se. 18, Se. 20, 1931....Q 0.20
Noranda Mines	20½	10½	10⅝	October, 1930..... 0.50
Park Utah Con	2.25	0.87½	1.50	July, 1929.....Q 0.20
Patiño M. & E	10½	4.12½	6.12½	December, 1929..... 4s.
Phelps Dodge	11⅝	6.75	7.00	Je. 18, Jy. 1, 1931.....Q 0.25
Rand Mines	22	12	12	August, 1930..... 1.52
St. Joseph Lead	15⅞	10	10	De. 10, De. 21, 1931...Q 0.25
Seneca Copper	0.87½	0.37½	0.37½	.....
Tennessee Corp	5.25	2.75	2.75	Fe. 28, Mh. 16, 1931...Q 0.125
Texas Gulf Sulphur	35⅞	21⅛	21⅞	Se. 1, Se. 15, 1931.....Q 0.75
U. S. S. R. & M	20⅜	12⅜	15	Jy. 2, Jy. 15, 1931.....Q 0.25
U. S. S. R. & M., pfd	41⅜	35	38	Jy. 2, Jy. 15, 1931.....Q 0.87½
Utah Copper	.....	.....	100*	Se. 18, Se. 30, 1931....Q 1.50
Vanadium Corp	29	16½	16½	Fe. 2, Fe. 16, 1931.....Q 0.75
NEW YORK CURB EXCHANGE				
Aluminum Co. of Am	130½	80⅜	80⅜	.....
Alum. Co. of Am., pfd.	99⅜	88	88	Mr. 14, Ap. 1, 1931....Q 1.50
Anglo-Chilean Con	1.00	0.62½	0.62½	4 shares Cosach B...June, 1931
Bunker H. & S	30	24	24⅜	My. 29, Je. 5, 1931.....0.25
Carnegie Metals	.....	.....	1.12½	.....
Comstock Tunnel	0.50	0.25	0.50	.....
Con. Coppermines	2.00	1.00	1.00	.....
Copper Range	4.00	4.00	4.00	July, 1930..... 0.25
Cresson Consolidated	0.43⅜	0.31½	0.31½	Je. 30, Jy. 10, 1931.....Q 0.01
Cusi Mexicana	0.43⅜	0.18⅜	0.43⅜	.....
Evans-Wallower	0.68⅜	0.62½	0.62½	.....
Federated Metals	8.00	7.50	7.50	Ja. 5, Ja. 15, 1931.....Q 0.25
Hecla Mining	5.62½	5.00	5.50	Au. 15, Se. 1, 1931....Q 0.10
Hollinger Consolidated	6.00	4.12½	4.25	Oc. 21, No. 4, 1931...M 0.05
Hudson Bay M. & S	3.75	2.00	2.25	.....
Iron Cap Copper	0.62½	0.62½	0.62½	.....
Mayflower Associates	27⅛	22½	23	Se. 1, Se. 15, 1931.....Q 0.50
Mining Corporation	1.75	1.75	1.75	December, 1929..... 0.12½
New Jersey Zinc	36	25⅛	26⅞	Jy. 20, Au. 10, 1931.....Q 0.50
Newmont Mining	28	14⅝	14⅝	Mh. 31, Ap. 15, 1931..Q 1.00
N. Y. & Honduras Ros	11	9.87½	11	Jy. 21, Jy. 31, 1931.....Q 0.25
Nipissing	1.50	0.87½	0.93¾	Mh. 31, Ap. 20, 1931..Q 0.075
Ohio Copper	0.18⅜	0.12½	0.18⅜	September, 1926..... 0.03
Premier Gold	0.62½	0.37½	0.43¾	Je. 11, Jy. 3, 1931.....Q 0.03
Quincy	2.00	2.00	2.00	March, 1920..... 1.00
Shattuck Denn	3.50	2.00	2.00	.....
So. Am. Gold & Plat	1.12½	1.00	1.00	.....
Teck-Hughes	6.50	4.00	4.25	Jy. 18, Au. 1, 1931.....Q 0.15
Tonopah Mining	.....	.....	0.50*	October, 1929..... 0.07½
United Eastern	.....	.....	0.06½*	.....
United Verde Ex	8.00	5.50	5.62½	Oc. 2, No. 2, 1931....Q 0.25
Utah-Apex	0.75	0.75	0.75	December, 1929..... 0.02
Yukon Gold	0.12½	0.12½	0.12½	June, 1918..... 0.02
BOSTON STOCK EXCHANGE				
Isle Royale	3.00	1.75	1.75	March, 1930..... 0.50
Mohawk Mining	15⅜	12	12	Oc. 31, No. 28, 1931...Q 0.25
Old Dominion	2.25	1.50	1.50	December, 1918..... 1.00
Utah Met. & Tunnel	0.35	0.21	0.21	December, 1927..... 0.30
MONTREAL				
Asbestos Corp	0.35	0.25	0.25	January, 1926..... 1.50
Asbestos Corp., pfd	0.50	0.50	0.50	January, 1930..... 1.75
Consolidated M. & S	89⅛	65	65	Je. 23, Jy. 15, 1931...SA 1.25

Company Name	High	Low	Last	§Most Recent Dividend
SPOKANE				
Constitution	.....	.....	0.06¼*	.....
Dayrock	.....	.....	0.95*	March, 1930..... 0.03
Golconda	0.23	0.22½	0.22½	July, 1929..... 0.02
Jack Waite Con	0.34	0.28	0.28½	.....
Los Lugos	.....	.....	0.01⅜*	.....
Mexican Premier	0.19½	0.13	0.17	January, 1930..... 0.01
Montana Mines	.....	.....	0.09*	.....
Noble Five	.....	.....	0.03*	January, 1930..... 0.005
Pend Oreille	.....	.....	0.65*	.....
Sherman Lead	.....	.....	0.31½*	March, 1930..... 0.01
Sidney	.....	.....	0.05*	October, 1929..... 0.01
Sunshine Mining	1.25	0.83½	1.00	December 20, 1930....Q 0.03
Tamarack & Custer	.....	.....	0.17½*	September, 1924..... 0.25
SALT LAKE CITY				
Chief Con	0.43	0.32	0.41	February, 1928..... 0.10
Combined Metals	0.07½	0.07½	0.07½	.....
Eureka Bullion	0.20	0.13½	0.18	.....
Eureka Lilly	0.13	0.11½	0.13	.....
Moscow Silver	0.40½	0.40	0.40	.....
New Quincy	0.14½	0.04½	0.13½	September, 1929.....Q 0.10
North Lily	0.71	0.53	0.70	January, 1930..... 0.15
Park Bingham	0.02	0.01½	0.01½	.....
Park City Con	0.17½	0.13½	0.17½	.....
Rico Argentine	0.04	0.03¾	0.04	December, 1929..... 0.03
Silver King Coalition	5.00	4.35	4.85	De. 20, Ja. 2, 1931.....Q 0.15
Tintic Lead	0.80	0.67	0.80	.....
Tintic Standard	3.65	3.20	3.50	Se. 18, Se. 30, 1931....Q 0.10
Walker Mining	1.15	0.97	1.00	April, 1930..... 0.075
TORONTO				
Abana Mines	0.05	0.02½	0.02½	.....
Amulet Mines	0.19	0.16	0.16	.....
Barry-Hollinger	0.11½	0.09	0.09	.....
Base Metals	1.00	1.00	1.00	.....
Canam Metals	0.02½	0.02	0.02½	.....
Castle-Trethewey	0.24	0.15	0.22	.....
Central Manitoba	0.10½	0.08½	0.08½	.....
Falconbridge	1.10	0.90	0.99	.....
Granada Gold	1.25	1.12	1.15	.....
Howey Mines	0.35	0.28	0.30½	.....
Keeley	0.31	0.23	0.31	March, 1928..... 0.04
Kirkland Lake	0.70	0.57	0.59½	.....
Lake Shore	27½	26½	26½	Se. 1, Se. 15, 1931.....Q 0.50
Sherritt Gordon	0.60	0.49	0.51	.....
Siscoe Gold	0.57	0.49	0.49	.....
Sylvanite	0.82	0.65	0.70	De. 5, De. 20, 1930...SA 0.02
Treadwell Yukon	1.60	1.00	1.25	.....
Ventures	0.68	0.44	0.49	.....
Vipond Con	0.71	0.60	0.64	April, 1927..... 0.03
Waite-A.-M	1.00	1.00	1.00	.....
Wright-Hargreaves	3.25	2.85	2.91	Je. 15, Je. 30, 1931.....Q 0.05
ST. LOUIS, CINCINNATI, AND DENVER				
Consolidated L. & Z	.....	.....	.....	December, 1929..... 0.125
Eagle-Picher	5.75	5.25	5.37½	April, 1930..... 0.20
Eagle-Picher, pfd	.....	.....	89*	De. 31, Ja. 15, 1931....Q 1.50
Empire Chief	0.00⅜	0.00⅜	0.00⅜	.....
Star of Utah	0.18	0.15½	0.18	.....
Tungsten Prod	.....	.....	0.06*	.....
West Gold	.....	.....	0.37½*	.....
SAN FRANCISCO, LOS ANGELES, AND COLORADO SPRINGS				
California Copper	0.37½	0.25	0.37½	.....
(a)Golden Cycle	13½	12½	12½	Au. 31, Se. 10, 1931.....Q 0.40
(a)Granite Gold	0.18	0.17½	0.17½	Je. 22, Jy. 1, 1931.....Q 0.01
Idaho-Maryland	0.91	0.57	0.74½	.....
Tom Reed	0.70½	0.60	0.63	Je. 10, Jy. 1, 1931.....Q 0.03
(a)United Gold	0.07	0.06	0.06	February, 1930.....0.01

‡LONDON

Company Name	High	Low	Last	Most Recent Dividend (Per Cent, Unless Noted)
Anglo American	12/–	8/3	10/6	22½, Feb. 19, 1930
Aramayo Mines	19/4½	15/–	17/6	5, Oct. 23, 1929
Burma Corporation	9/6	5/7½	9/–	1¼, Dec. 10, 1930(*b*)
Camp Bird	6d	6d	6d	16¾, April 25, 1928
Fresnillo	.....	.....	8/9*	25 cents, Feb. 12, 1930
Frontino & Bolivia	12/1½	12/1½	12/1½	2½, July 1, 1931
Lake View & Star	9/1½	7/–	8/3	11¼, 1921
Mexican Corporation	5/3	2/6	5/–	10, Oct 24, 1929
Oroville Dredging	1/9	1/3	1/9	37½, May 16, 1930
Rhokana Corporation	91/3	57/6	80/–	.....
Rhodes.-Select. Trust	8/6	6/3	7/6	.....
Rio Tinto	390/–	228/9	375/–	10s, May 1, 1931
St. John del Rey	21/–	17/7½	19/6	8¾, May 1, 1931
San Francisco Mines	12/7½	7/–	10/9	10, Jan. 7, 1931
Santa Gertrudis	8/6	5/9	8/–	9d., July 9, 1931
Selukwe	.....	.....	1/9*	6¼, April 2, 1917
So. American Copper	1/3	1/–	1/1½	.....
Tanganyika	20/9	13/9	20/–	2½, Aug. 2, 1930
Wiluna Gold	7/9	5/10½	7/–	.....
Union Minière	4,250	2,925	3,600†	240 francs, July, 1931

Salt Lake Stock Exchange courtesy J. A. Hogle & Company, Spokane Standard Exchange courtesy the Pohlman Investment Company. *Not traded in. †Belgian Francs. ‡The above London quotations are for the month ended Sept. 26. Q, quarterly; I, initial; M, monthly; X, extra; SA, semi-annual; L, liquidating. B, plus bonus. §Total dividends paid during the month will be found tabulated in the Market and Financial News Section. Dates here given are those of closing of books and payment of dividend. (*a*) Bid prices. (*b*) 1¼% (2 annas) dividend, and bonus of ¼% (1 anna). (*c*) Closing bid prices.